Design and Construction

August 2007

Standards and Guidelines For School Facilities

Alberta Infrastructure and Transportation

Table of Contents

1.0 Introduction 1
1.1 General 1
1.2 Purpose and Scope of the Document 1
1.3 Guiding Principles 2
1.4 Project Submission and Review Process 2
1.5 Regulatory Requirements 3
1.6 Design Process and Methodology 3
1.7 General Design Considerations 5
1.8 Sustainability 6

2.0 Building Elements 8
2.1 Building Structure 8
.1 Design Loads 8
.2 Foundations 9
.3 Structure 9
.4 Interaction with Other Disciplines 10
.5 Design Parameters To Be Shown On Drawings 11
2.2 Building Envelope 11
.1 General 11
.2 Roofing 12
.1 General 12
.2 Near-Flat Roofs 13
.3 Steep Roofs 14
.4 Skylights, Sloped Glazing and Clerestory Windows 15
.5 Unoccupied Spaces 15
.3 Exterior Walls 16
.1 General 16
.2 Air Barrier 17
.3 Insulation 18
.4 Cladding 18
.5 Windows and Doors 19
2.3 Building Interiors 20
.1 General 20
.2 Walls 20
.3 Interior Finishes 20
.4 Interior Glazing 21
.5 Doors and Hardware 21
2.4 Millwork 21
.1 General 21
2.5 Other Building Construction 21
.1 Acoustics 21
.1 General 21
.2 Definitions 22
.3 Design Guidelines 22
.4 Interior Walls 26
.5 Site Planning 27
.2 Hazardous Materials 28
.1 General 28
2.6 Building Site Work 28
.1 Site Services 28
.1 General 28

Alberta
Infrastructure and Transportation

Table of Contents

.2 Landscape Development 32
.1 References 32
.2 Exterior Landscape Development 33
.3 Planting Near Buildings and Utilities 34
.4 Interior Landscape Development 34
.5 Environmental and Conservation Considerations 35
.6 Playgrounds and Sports Fields (not funded by Alberta Infrastructure) 35
2.7 Mechanical 35
.1 General 35
.1 References 35
.2 Refer to the following references for guidance: 36
.3 General 37
.4 Design Criteria 37
.5 Energy Performance Objectives 39
.6 Target Building Energy Performance Index (BEPI) 39
.2 Heating 40
.1 General 40
.2 Boilers 40
.3 Heating Distribution 40
.4 Heating Terminals 41
.5 Heating Systems 41
.3 Ventilation 42
.1 General 42
.2 Air Handling Equipment 43
.3 Humidification 44
.4 Zoning 44
.5 Distribution 45
.6 Exhaust and Equipment Discharges 45
.7 Variable Air Volume (VAV) 45
.8 Rooftop Units 46
.9 Special Ventilation Systems 46
.4 Cooling 47
.1 General 47
.2 Refrigeration Equipment 47
.3 Chiller Sizing 48
.4 Cooling Distribution 48
.5 Cooling Systems 48
.5 Plumbing and Drainage Systems 48
.1 Plumbing Piping Systems 48
.2 Plumbing Fixtures 50
.6 Fire Protection 50
.1 General 50
.2 Sprinkler Systems 50
.3 Standpipe and Hose Systems 50
.4 Portable Fire Extinguishers 51
.7 Noise and Vibration Control 51
.1 Background Noise 51
.2 HVAC Noise 51
.3 Plumbing Noise 52

Alberta Infrastructure and Transportation

Table of Contents

.4 Vibration Isolation ... 53
.8 Controls ... 53
.1 General Requirements ... 53
.2 EMCS Design Objectives ... 54
.3 EMCS Operating Objectives ... 54
.4 Field Devices ... 55
.5 Contract Documents ... 55
.6 Start-up, Testing and Point Verification ... 56
.9 Commissioning ... 56
2.8 Electrical ... 57
.1 General ... 57
.2 Services and Power Distribution ... 58
.1 Electrical Service ... 58
.2 Power Distribution System Protection and Control ... 59
.3 Switchgear, Switchboards and Panelboards ... 59
.4 Transformers ... 60
.5 Feeders ... 61
.6 Power Factor ... 62
.7 Harmonic Distortion and Noise ... 62
.8 Transient Voltage Suppression ... 63
.3 Motor Control ... 63
.1 General ... 63
.2 Motor Starters ... 63
.3 Motor Protection and Control ... 64
.4 Variable Frequency Drives ... 64
.4 Emergency Power System ... 64
.1 General ... 64
.2 Emergency Generator ... 65
.5 Lighting ... 67
.1 General ... 67
.2 Recommended Lighting Levels ... 67
.3 Uniformity ... 68
.4 Luminaires ... 68
.5 Lighting Sources ... 68
.6 Ballasts ... 69
.7 Daylighting ... 69
.8 Lighting Controls ... 69
.9 Exterior Lighting ... 70
.10 Emergency Lighting ... 70
.11 Exit Luminaries ... 70
.6 Wiring Materials and Methods ... 71
.1 General ... 71
.2 Conductors ... 71
.3 Conduit and Raceways ... 71
.4 Wiring Devices and Equipment ... 72
.5 Provisions for Computer Based Equipment ... 72
.6 Block Heater Outlets ... 73
.7 Provisions for Mechanical ... 73
.7 Fire Alarm System ... 74
.1 General ... 74
.2 System ... 74

Alberta Infrastructure and Transportation

Table of Contents

.8 Security Systems 75
  .1 General 75
  .2 Security System Application 75
.9 Data and Communication Systems 75
  .1 General 75
  .2 Data Cabling 76
  .3 Telephone Cabling 76
  .4 Communication Systems 76
  .5 Cable Television System 77
.10 Miscellaneous 77
  .1 Lightning Protection 77
  .2 Envelope Penetrations 78
  .3 System Demonstration and Commissioning 78

Alberta Infrastructure and Transportation

1.0 Introduction

1.1 General

This document is intended to provide assistance to the current decision making process being followed by School Boards within Alberta with respect to the design and construction of school facilities.

The standards and guidelines presented are not intended to be prescriptive to the degree of restricting creative thinking. Rather, it is intended that the information provided will help facilitate the development of facilities that represent best value for expenditure while creating the most appropriate possible environment for learning.

This document is part of a compendium of information that collectively, will provide supplemental information to the School Board and their project decision-makers.

1.2 Purpose and Scope of the Document

The purpose of this document is to provide standards and guideline material that is appropriate to and consistent for school facilities.

It is intended to provide a framework for new facilities and for modernization projects.

The standards and guidelines presented relate to the technical design of facilities and need to be used in conjunction with professional judgement to ensure they are followed to the extent that they are appropriate. It is intended that School Boards and their consultants retain control and ultimate responsibility for the educational requirements, design and construction within the allocated funds.

The intent of this document is to:

.1 Describe the minimum requirements for various building components, assemblies and systems that have an impact on serviceability and anticipated life cycle of the facility.

.2 Alert School Boards and consultants to design aspects that are perceived to be problematic.

.3 Provide possible solutions and/or problem avoidance techniques that have in the past proven to be practical and effective.

.4 Provide a vehicle for communicating common school facility issues throughout the industry in an effective and expedient manner.

.5 Provide a basis for evaluating school facility project submissions.

.6 Provide construction cost guidelines (or Support Prices) for budgeting new school projects, and recommend new guidelines for controlling costs within allocated budget.

Alberta Infrastructure and Transportation

It is not intended that this document address every conceivable condition. Rather, it attempts to apply common sense to provide solutions where experience has indicated that problems commonly arise. This should be applied to new facilities and to existing facilities undergoing change in order to address the technical issues identified within this document.

Where issues arise that are not addressed within this document, or where it is determined that the specific item is not appropriate for the project, it is anticipated that the decision-makers will apply due diligence in determining appropriate measures.

It should be understood that when these standards and guidelines apply to modernization projects, there is the need for flexibility in their application, due to the need to respect existing systems and conditions.

1.3 Guiding Principles

.1 Design facilities within a methodology that includes a process of life cycle costing.

.2 Develop standards and guidelines to facilitate design that provides best value for expenditure both short and long term.

.3 Design facilities that maximize flexibility of use and the potential for re-adaptation over time.

.4 Create spaces and environments that are comfortable and supportive of the educational delivery process.

1.4 Project Submission and Review Process

It is anticipated that each project will be submitted to Alberta Infrastructure during the design process. Submission will typically occur at completion of the Design Development Phase. It is not intended or expected that this review will impact the project schedule. It is recommended in order to facilitate the review, that a preliminary submission occur upon completion of the Schematic Design Phase. Should Alberta Infrastructure determine any issues for discussion, these will be identified quickly and discussed directly with the School Board. Throughout the project, Alberta Infrastructure is available on a request basis, to provide assistance where it is felt to be a benefit.

Since prior to award of the construction contract, projects require ministerial approval, there will be a formal submission of summary information to Alberta Infrastructure following tender close.

Further information related to the involvement of Alberta Infrastructure and the various processes required are available within the policy document of the compendium.

1.5 Regulatory Requirements

Each project will be governed by specific building code, regulatory, provincial and municipal requirements. Determination of these requirements should occur at the earliest possible time in order to appropriately assist the development of the design as well as to adequately account for overall cost impacts of specific building requirements.

Design should not proceed until an analysis of these factors has been made and appropriate discussions with the various authorities undertaken.

1.6 Design Process and Methodology

Prior to commencing the formal design process, the School Board will typically identify specific project information to facilitate the design process. This will usually include a functional project program; specific site related information; a project budget; and the identification of the project team members.

The design and construction process incorporates all prior planning; educational specifications; site studies; codes and regulations; and financial parameters; into written and graphic documentation that form the basis for constructing the facility.

Normally, the design process consists of five basic phases, which follow the development of a functional program as defined in the educational specification.

.1 Schematic Design
.2 Design Development
.3 Construction Documents
.4 Tender
.5 Construction

Each of the first four phases is generally completed with the issue of the Prime Consultant's Report, supplemented with a Cost Report (Cost Check) prepared by a professional cost consultant to ensure the project is within budget.

Additionally, facility design includes an assessment of the following:

.1 Accessibility
.2 Codes and Ordinances
.3 Energy Conservation
.4 Environmental/Health Requirements
.5 Value Analysis
.6 Quality Assurance Program and Commissioning
.7 Needs Assessment

A more detailed description of project phases, normal consultant services and recommended fees and conditions of engagement are available through the Alberta Association of Architects (Telephone: 780-432-0224).

Alberta Infrastructure and Transportation

1.0 Introduction

During the <u>Schematic Design Phase</u>, the educational specifications and functional program are translated into graphic form with input from all consultants involved.

Within the <u>Design Development Phase</u> more precise planning, preliminary specification and graphic representation are developed to illustrate and define the design concept in terms of siting, plan form, character, materials, and structural, mechanical and electrical systems.

The <u>Construction Documents Phase</u>, which forms the construction contract, represents the culmination of the design process and the point at which final decisions are taken to tender and ultimately to construct the facility.

For the <u>Tender Phase</u> following project design various methods for contractor selection and project delivery are possible. The document "Contracting Directives for Funded Infrastructure Projects" should be reviewed in this regard.

Following decisions regarding the method for construction and selection of the contractor, the <u>Construction Phase</u> creates the physical building form. During this phase, the project team typically represented by the consultant group, periodically reviews construction in order to determine its compliance with the construction documents.

Most project's Quality Assurance Program require specific materials and/or systems testing during construction and commissioning. It is recommended that control of this be retained by the School Board rather than by the contractor.

In order to develop a methodology best suited for the design process, the following should be considered:

.1 Prior to design, undertake a geotechnical, environmental and legal/typographic investigation of the specific site.

.2 For modernization projects undertake studies related to hazardous materials, roof conditions, structural distress and systems operations.

.3 Develop a specific user needs program including client supplied items.

.4 Develop a financial plan and realistic project construction budget.

.5 Select a consultant team with appropriate related experience and capabilities plus the ability to integrate within the project team.

.6 Select a project team that will be effective and efficient. Include a professional cost consultant to provide cost control and cost advisory services.

.7 Ensure that a client representative on the project team is empowered to undertake decisions.

Alberta
Infrastructure and Transportation

.8 Develop realistic approvals and project schedule recognizing reasonable timelines for both design and construction as well as time necessary for the various approvals required.

.9 Develop a quality management strategy.

.10 Consider cost value analysis as an integral part of the decision making process.

1.7 General Design Considerations

While it is acknowledged that all projects are unique and therefore require specific and individual attention, it is felt that there are a number of generic design considerations, which typically apply to all or most projects.
The following is not intended to be a total list but rather should be considered a starting point from which the specific project design evolves:

.1 Building design should reflect function, a simple design is preferred, shape of building should minimize length of perimeter walls and number of roof levels.

.2 Design should consider flexibility of space use.

.3 Design to meet the present needs of the School Board and to recognize that future need changes should as much as possible, be achievable through adaptive reuse.

.4 Design to achieve the program needs within the School Board's budget.

.5 Design using systems and equipment that are attainable within the timelines of the project. Analyze their cost implications to maintain a proper balance of costs among all the elements of the design.

.6 Innovations are encouraged but experimentation at the School Board's expense must be avoided.

.7 Technological change and advancements require consideration in design.

.8 Consider the need for school buildings to support community oriented activities.

.9 All school buildings are to be accessible as per code requirements.

.10 Facilitate a Quality Assurance Program. Quality management is an important aspect of the process requiring verification that what has been designed and what has then been constructed, achieves the criteria originally established.

.11 Design to consider low fire hazard, good resistance to misuse and vandalism, and good security against illegal entry.

.12 Design facilities with energy conservation and occupant comfort in mind.

.13 Consider using value analysis to undertake decisions considering longer term operation and maintenance implications.

.14 All mechanical and electrical components require easy access for cleaning, servicing and replacement.

.15 Avoid trendy colour and finish schemes, which may become outdated and evaluate colours and finishes based upon behavioral impact, cost and deterioration factors.

.16 Roofing should be designed for access by maintenance staff and for future replacement.

.17 Exercise a preference for materials that demonstrate a greater degree of responsibility to the environment.

1.8 Sustainability

1.1 Reference

.1 *LEED Green Building Rating System for New Construction and Major Renovations,* Canada Green Building Council, 2004.

.2 *Commercial Building Incentive Program Technical Guide*, Natural Resources Canada, Ottawa, 2000.

1.2 General

.1 All new buildings and major renovations shall be certified to a minimum LEED Silver rating. (Current unit rates for school projects support LEED Silver.) In the absence of sustainable opportunities, where the mandatory credits can not be achieved, or where sufficient optional credits can not be economically achieved, projects with a capital budget less than $2.5 million may be exempt at the discretion of the project team, however, integrated and sustainable design practices should be incorporated.

.2 LEED Green Building Rating System is a voluntary, consensus-based standard for developing healthy and high performance buildings with reduced environmental impacts. The rating system evaluates "greenness" from a whole-building and whole-life perspective in five categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality. LEED promotes integrated and sustainable design practices.

.3 "Integrated design" is a collaborative process between the client group including occupants, operating staff and a multi-disciplinary design team, focusing on the design, construction, operation, and occupancy of a building over its complete life cycle. Functional, environmental, and economic goals are defined and realized by proceeding from whole building system strategies, through increasing levels of specificity, to achieve more optimally integrated solutions.

.4 “Sustainable design” is an integrated approach to building design, construction, and operation that focuses on the efficient use and choice of resources and materials in such a way as to be economical while not compromising the health of the environment or the associated health and well being of the building’s occupants, builders, the general public, or future generations.

.5 All projects should incorporate, as much as possible, sustainable design concepts using the integrated design process. Studies indicate that the impact of greater occupant satisfaction and comfort resulting from increased individual control over the indoor environment: temperature, air movement, noise, lighting, exterior views and daylight, improves productivity, wellness and retention.

.6 Major renovations must incorporate substantial revisions to building envelope, heating, ventilation and air conditioning, and lighting before LEED Silver rating is required.

.7 Should manufactured wood products be used, LEED Canada NC, Version 1, Materials and Resources Credit 7 makes specific reference to wood products certification. The use of forest, wood or engineered wood products locally manufactured under all recognized certification systems is encouraged. For reference purposes and without endorsement, the forest and wood product certification systems available in Alberta include Forest Stewardship Council (FSC), Canadian Standards Association (CSA), Sustainable Forestry Initiative (SFI), and Forest Care.

2.1 Building Structure

.1 Design Loads

.1 Classrooms: Minimum floor occupancy live load 2.4 kPa or 4.5 kN concentrated, whichever produces the more critical effect.

.2 General office and Laboratory areas: Minimum floor occupancy live load 3.6 kPa or 9 kN concentrated, whichever produces the more critical effect. Consider potential for changes in space use (i.e. classroom to library).

.3 Records storage and library shelving areas: Design live load to be based on type and layout of proposed storage or shelving system, but not less than 7.2 kPa.

.4 Corridors, Assembly Areas, Auditoriums, Gymnasiums, Stages and Dining Areas: Minimum floor occupancy live load 4.8 kPa or 9 kN concentrated, whichever produces the more critical effect.

.5 Mechanical loads: Obtain loads from mechanical consultant. In mechanical rooms, allow for a minimum of 100 mm thick concrete housekeeping pads or 100 mm thick concrete floating slab. Refer to acoustic requirements and coordinate with mechanical consultant. Ensure that the structure contains adequate access routes for heavy equipment. Ensure that the structure has adequate capacity for suspended piping loads.

.6 Minimum roof design live load: 1.5 kPa or 1.5 kN concentrated, whichever produces the more critical effect. For roofs over mechanical rooms, increase the concentrated load to 4.5 kN for all elements except metal deck. Roof structures shall be designed for the ponded rain load associated with a plugged roof drain. Gymnasium roof structures shall be designed with special consideration for suspended loads. This includes moveable partitions in the extended and stacked position, and basketball backboards in the extended and stowed positions.

.7 For buildings that are to be close to property lines on urban sites, assume the neighbouring property will be built higher than the school. The assumed height of the neighbouring property shall be based on the local zoning by-law. This typically will produce a triangular snow load with an accumulation factor, C_a, of 3.75 at the property line.

.8 If there is a known plan to change the usage of an area in the future, design for the more stringent of current and future live loads.

.2 Foundations

.1 Aspects of design and construction that depend on soil or groundwater conditions shall be reviewed and approved by a geotechnical engineer.

.2 Maintain the integrity of existing structures and service lines on adjacent properties.

.3 Do not incorporate "tie-back" earth retaining system as an essential part of the permanent structure.

.4 The weight soil fill and the associated pressure shall be treated as a live load, with a load factor of 1.5. If the weight of the soil is used to counter-act uplift or overturning, it shall be treated as a dead load with a load factor of 0.85.

.3 Structure

.1 Do not use unbonded post-tensioned reinforcement as an essential reinforcing element of a structural member.

.2 Design cantilever or continuous steel beams according to *Roof Framing With Cantilever (Gerber) Girders and Open Web Steel Joists*, published by the Canadian Institute of Steel Construction, July 1989. **Do not use Gerber design for floor construction**.

.3 Design exterior slabs at doorways to avoid interference with outward door swings as a result of upward movement of slab caused by frost. Provide structural stoop where necessary.

.4 Provide protection against corrosion for structural elements that may be subject to spills or leaks of corrosive solutions (e.g., mechanical floors supporting brine tanks and water softeners).

.5 Design expansion joints, including those between existing and new structures, so that an abrupt change in floor elevation is prevented.

.6 In major renovations of existing facilities, investigate safety with respect to current seismic loading in areas where this is applicable. Upgrade as deemed appropriate for the specific project. At a minimum, ensure adequate lateral support for all non-structural components.

.7 Design structural steel floors to prevent transient footstep induced vibration from exceeding the annoyance threshold. Refer to CISC Handbook for Steel Construction – Appendix G, Guide for Floor Vibration, and Commentary A - Serviceability Criteria for Deflections and Vibrations in the National Building Code of Canada.

.8 Gymnasium roof structures and other longer span structures using joists shall be proportioned in consideration of the deflection adjacent rigid end walls. The deflection shall be limited to ensure the integrity of the roof diaphragm and to keep roof deck stresses to an acceptable level.

.9 When designing HSS trusses, proportion members and select wall thicknesses in consideration of accepted HSS connection design principles.

.10 Provide drain holes to allow the release of water in all HSS subject to freezing.

.4 Interaction with Other Disciplines

.1 Structurally design and detail the fastening, support, and back-up systems for exterior walls, brick veneers, cladding, and attachments. Steel connections outside the air barrier shall be galvanized and all welded connections shall be shop welded.

.2 Where possible, avoid thermal bridging. Where this is not possible, incorporate measures to minimize its effect. Refer to Building Envelope Section.

.3 In the design of exterior wall back-up systems, limit deflections according to the properties of the cladding or veneer material being used.

.4 Provide details that allow for all building movements, including deflections.

.5 For roof slopes, refer to Building Envelope Section, “Roofs”. Structural design must consider the resulting non-uniform loads caused by accumulation of rain water. The removal of rain water at drains can be restricted by hail associated with a major rainfall. Roof structures shall be designed for the effects of a plugged drain, and should be designed such that the effect of rain is less stringent than the effect of snow.

.6 Check the structural adequacy of support systems for ceilings, particularly heavy plaster ceilings, and follow up with on-site inspection.

.7 Structurally design and detail all required guardrails.

.8 Advise the architect of expected movements of the structure, including those caused by deflection, shrinkage, settlement, and volume changes in the soil. Adequate allowances must be provided in all affected elements, including partitions and mechanical systems.

.9 If the expected movement of a grade-supported floor slab cannot justifiably be accommodated or tolerated, use a structural slab. A crawl space may not be necessary and should be provided only in cases where the benefits justify this approach. If a slab is constructed over a void form, ensure that the buried plumbing is adequately suspended from the floor slab, and that it is isolated from the soil such that soil movement will not damage the piping or induce loads into the slabs.

.10 Specify concrete floor flatness that is consistent with the flooring material to be applied and the architect's aesthetic requirements. Due to the higher cost involved, specify unconventionally stringent flatness only for areas where there is a justifiable benefit.

.11 Ensure adequate stiffness of lightweight roof or other structure that supports mechanical equipment with spring isolators. Resonance problems can usually be avoided if the additional structural deflection caused by the equipment load, does not exceed 6 mm or 7% of the vibration isolator static deflection, whichever is less. Coordinate with Mechanical Consultant.

.5 Design Parameters To Be Shown On Drawings
(For review, construction, and future reference)

.1 Geotechnical design parameters

.2 Structural design parameters, including:

- design loads
- provisions for future additions
- material properties

.3 Criteria for design to be done by contractors

.4 Existing grade, finished grade, main floor and foundation elevations

.5 Any special construction procedures assumed in design

2.2 Building Envelope

.1 General

Building envelope assembly separates spaces requiring differing environmental conditions by controlling the flow of air, moisture and energy.

Materials used in the building envelope assembly should be suitable for the environmental conditions to which each will be exposed, including during the construction period. Materials should provide a service life consistent with accessibility for maintenance of building components and planned building life.

Detailing of the envelope must ensure that water, snow and ice sheds safely from exterior surfaces, is not trapped in the assembly to cause deterioration and does not cause staining of finishes.

Suitability of materials, location and design detailing for membranes and barriers is crucial to the long term success and survival of the building envelope.

Elements that penetrate the building envelope should be avoided. Where they occur, thermal separation and control will be necessary, as will considerations for membrane and air barrier integrity.

Where detailing for exterior envelope finishes appear to continue to the interior, an appropriate seal at the breakpoint of transition will be necessary.

Generator exhaust penetrations where they exist and penetrate the envelope, a ULC rating or equivalent should be provided.

.2 Roofing

.1 General

Selection of a roof system and design for its detailing must recognize the environmental conditions that will apply, the anticipated service life for its components and the degree to which ongoing maintenance will be necessary.

Consider the following:

- Provision of adequate slopes for drainage of roofs generally and specifically at roof-mounted equipment and penetrations.
- Provision of membranes below all metal roofing and flashings considering metal roofings and flashings as “water shedding” rather than “waterproofing”.
- Location of outlets and interior drainage pipes which discharge to the outside at a location sufficiently above grade so as to preclude damming and backup into the building.
- Avoidance of scuppers except as emergency overflow devices.

- Provision of a main interior access to the roof with all separate levels of roofs connected at least by external ladders.
- Detailing for potentials for vandalism and safety.
- Interior drainage.
- Development of details as recommended by the Alberta Roofing Contractors' Association (ARCA).

.2 Near-Flat Roofs

- Slope all roof surfaces to drains including valleys and transverse slopes across top of parapets.
- Provide minimum slope to drain of 1:50 for field of roof.
- Preferably use internal roof drain systems with open flow drains and minimum 100 mm pipes. Avoid the use of control flow drains.
- Generally use a minimum of two roof drains per contained drainage area. Overflow scuppers should be used where this is not practical and where structural hazards would result from blockage in drain leaders. An emergency roof drain located approximately 150 mm vertically upslope from the main drain and leadered directly outside is an acceptable alternate.
- Form slopes in the structure. Avoid the wide spread use of insulating fill or tapered insulation to obtain slopes.
- Where a lower roof is impacted by flow from upper roof conditions, ensure design accommodates the increased volume and structural loading factors.
- Maintain a practicable constant elevation around the perimeter of the contained roof area. If a varying perimeter cannot be avoided, provide dimension details of low and high edge conditions.
- Provide curbs minimum 200 mm above the roof membrane level for all penetrations. Locate raised equipment so that they do not impede drainage and have minimum 1 m clearance around and under to allow for roof application.

- Where a roof joins a wall that is extending above the roof, locate wall cladding, windows, doors, louvres and other wall penetrations a minimum of 300 mm above the top surface of the roof.

- Roofing connections to walls are recommended to be designed as protected membrane transitions in both conventional and protected membrane designs.

- Generally use gravel ballast with filter fabric for protected membrane systems with removable precast paver units around roof perimeters, around curbs (greater than 3 m any side), for access paths and for decks.

- When cast-in-place concrete top surface is unavoidable, special design considerations for drainage, venting and placing of concrete are necessary.

.3 Steep Roofs

- Design steep roofs (slopes greater than 1 to 6) with a plane of waterproofing membrane/air barrier following the plane of ventilated cladding.

- Configure steep roofs and perimeters so that snow, ice and rainwater will not create safety, maintenance or appearance problems. Design to prevent ice and snow from sliding into areas intended for use by vehicles or pedestrians. By not locating large steep roofs at building perimeter many design complications are avoided.

- Size eavestroughs to accommodate water from contributory roof and wall areas and to resist expected snow and ice loads. Off the shelf eavestroughs typically do not provide adequate resistance to dynamic loads from ice and snow. Locate eavestroughs so they are accessible for maintenance and will not cause leakage into the building.

- Observe the following minimum slopes for standard applications of shingles and shakes:

  - 1 to 3 for triple tabbed strip shingles
  - 1 to 2.4 for cedar shingles
  - 1 to 2 for cedar shakes

  Shallower slopes will require upgraded underlayment and increased head lap.

.4 Skylights, Sloped Glazing and Clerestory Windows

- Skylights and sloped glazing systems frequently become building envelope problems, triggering significant operation and maintenance costs to building owners.

- When light is to be introduced through the roof, vertical clerestory glazing is preferred over skylights and sloped glazing.

  When skylights or sloped glazing are to be used consideration of the following should be made:

  - Designs should be single slope or ridge (vertical end walls) only.
  - Sloped glazing minimum 30º from horizontal.
  - Design air seal connection to skylights, sloped glazing, curbs and adjacent walls to be fully accessible and not dependent on construction sequence.
  - Design skylights and sloped glazing so that they are accessible for maintenance and cleaning from building interior and exterior.
  - Make provision to drain water entering the glazing system back to the exterior during all seasons. Water may enter the glazing system as a result of condensation from air exfiltration.
  - Provide an interior condensation gutter system. It may be necessary to drain the collected interior surface condensation and drain at the sill to the mechanical plumbing system rather than relying on evaporation. Do not drain interior condensation directly to exterior.
  - Use a dry glazing system. Do not depend on sealants.
  - Architectural drawings should be minimum ½ scale to clearly show intent of drainage system.
  - Drawings must show anchorage, air seals, sheet metal backing, drainage.

.5 Unoccupied Spaces

Unoccupied spaces include such areas as attics and crawlspaces. Avoid creating such spaces that are to be unheated. These spaces should be made part of the overall integrated building envelope with suitable access.

- Design the enclosure for unoccupied spaces to be the same as the design of the building proper. Ventilation and heating requirements for such spaces need not be the same as for the occupied space; however, some modification of humidity and temperature may still be required.

- Minor features on the building exterior that enclose space such as mansards should be vented with exterior air. Suitable connections for air sealing are required.

- Provide access to interior unoccupied spaces from the interior and to exterior spaces from the exterior.

.3 Exterior Walls

.1 General

The design approach generally recommended is the PERSIST "pressure equalized rainscreen insulating structure technique". This approach is characterized by the following:

- A fully adhered air sealing component to the exterior of structural frame and structural infill. The air sealing component in combination with the underlying structural elements forms the air barrier system.

- Insulation in direct and firm contact with the air barrier system.

- Exterior cladding covering an air space pressure equalized with the exterior.

- Materials used suitable for the environmental conditions and service life consistent with accessibility for maintenance.

- Suitable drainage and venting.

- Penetrations of the air barrier plane must be co-ordinated between structural, mechanical, electrical and architectural disciplines to maintain air seal continuity.

  - Other design approaches are possible but in all cases the system selected should minimize the following:

    - Deterioration due to water, ice and snow.
    - Trapping of condensation from humid exfiltrating air.

- Retention within the wall system of moisture for extended periods.
- Movement of structural elements that exceeds air sealing component's adhesive and structural capacity.
- Displacement of insulation from intimate contact with the air barrier.

- Insulation:

  - Located to the exterior of structural components.

  - In direct contact with an air barrier system. An air barrier system which can also function as a vapour retarder.

  - Other design approaches are possible but in all cases the system selected should minimize the following:

    - Moisture deteriorating the building envelope due to ingressive exterior moisture and/or trapping of condensation from relatively humid air introduced into the envelope by air exfiltration.
    - Retention within the wall system of moisture for extended periods.
    - Detrimental affects on air barrier from exposure to UV radiation, extreme temperature fluctuations and moisture.
    - Thermally induced movement of structural elements at any connected air barrier.

- Materials used should be suitable for the environmental conditions and should be provide a service life consistent with accessibility for maintenance of the building components and the planned building life.

- Provide suitable drainage and venting to minimize moisture, drain moisture adequately and quickly dry areas that become moist.

.2 Air Barrier

The air barrier is an integral part of the overall success of a building envelope. It must be designed to carry the full air pressure difference across the envelope.

- Consider location of the air barrier exterior of structural elements (“PERSIST”).

- Minimize the number of materials used to form the air barrier system. Same manufacturer of materials for project may reduce compatibility problems.

- Minimize the number of changes of plane in an air barrier system and do not use of mixed approaches in new construction.

- At joints within materials and components and at junctions between assemblies (i.e. walls to roofs, windows to walls), provide suitable detailing to ensure continuity of the air barrier with consideration for differential movements and construction sequencing.

- Consider the need for compatibility of materials in contact with one another.

.3 Insulation

- Secure insulation mechanically so that it is in direct contact with the outside surface of the air barrier system.

- Consider placement of insulation to the exterior of structural elements to completely enclose non-cladding components of the envelope and to reduce thermal transfer (“PERSIST”).

- Insulate walls, roofs, soffits and foundation perimeters to optimize RSI values per the National Energy Code for Buildings. These values are and should be based on life cycle costing and may vary dependant upon energy sources and economic conditions.

.4 Cladding

- Cladding systems should be pressure equalized and drained to the exterior.

- Cladding attachment systems should minimize thermal bridging. Consider use of double z-bar and thermal clip systems over single z-bar.

- Consider impact loads.

- Consider staining from water, etc.

- Consideration for vandalism issues.

- Consider specialty colours or products, cost and/or deterioration issues.

.5 Windows and Doors

- Windows:

  - Choose window frames that will prevent condensation from forming on the frame at the interior design conditions and the 2.5% January design temperature.

  - Design window assemblies as pressure equalized, rainscreen systems with the main mass of the frame located to the interior of the thermal break. Do not use the frame to span the cavity between the inner wythe and the cladding.

  - Design window and interior surrounds to allow uniform air movement across the glass and frame.

  - It is recommended that low E glass be considered for all conditions.

  - For south and west exposures, consideration should be given for additional treatments such as tinted glass.

  - Coordinate glazing with the lighting and mechanical systems to avoid glare and solar overheating.

  - Window frame should incorporate mechanically keyed in dry gaskets interior and exterior.

  - Allow for tie-in of membrane air seal mechanically to structural body of frame interior of thermal break.

  - Do not use manual double glazing.

- Doors

  - It is recommended that vestibules be provided with glazed exterior doors at entries.

  - Doors and frames should not bridge cavity.

2.3 Building Interiors

.1 General

Building interiors create the environment for teaching, learning and in which staff work. Designs must respect these three distinct environmental considerations and must maximize the provision of each group's needs.

Combined with this basic requirement are specific objectives which may be somewhat conflicting. These include but are not limited to:

.1 Best value for expenditure.

.2 Operations and maintenance considerations.

.3 Adaptability and flexibility of space use.

.4 Specific area functional requirements.

.5 Safety and security issues.

.6 Code and regulatory agencies requirements.

.7 Accessibility needs.

.8 Spatial volume and acoustic requirements.

.9 Health considerations.

.10 Aesthetic and environmental considerations.

.2 Walls

.1 Consider whiteboards rather than chalkboards.

.2 Acoustic considerations (see Acoustic Section).

.3 Durability and maintenance issues.

.3 Interior Finishes

.1 Consider maintenance and replacement implications.

.2 Consider environmental/health issues (i.e. carpet off gassing and VOC's in paints, adhesives and coatings).

.3 Consider durability and potential for vandalism.

.4 Consider the use of carpet only in areas including music, part of ECS; part of staff offices and libraries.

.4 Interior Glazing

.1 Consider dry glazing where possible.

.2 Detailing and specifications to clearly indicate requirements.

.3 Specific code requirements for wall assemblies to be considered.

.4 Consider acoustic impacts.

.5 Doors and Hardware

.1 Consider safety, durability, possible vandalism issues.

.2 Key requirements based upon School Board policy.

2.4 Millwork

.1 General

Consider life cycle costs when determining the construction and materials of millwork units.

.1 Typically in classroom, ancillary, CTS and common areas, high quality construction should be considered with suitable durable finishes such as plastic laminate. Heavy duty hardware should also be anticipated. AWMAC Standards are recommended.

.2 In areas such as staff rooms and libraries while melamine finishes may be considered for vertical and unexposed surfaces, this decision should be based on a life cycle cost evaluation.

2.5 Other Building Construction

.1 Acoustics

.1 General

- The intent of these guidelines is to ensure that the acoustic environment in schools is conducive to learning and is compatible with the needs and comfort of students and staff. All instructional spaces should be designed for the attainment of high speech intelligibility.

- Isolate classrooms and libraries from spaces that generate high sound levels such as mechanical rooms, washrooms, lunchrooms, assembly areas, gymnasiums, music rooms, etc.

- Do not locate instructional spaces below corridors, lobbies or other high traffic areas to avoid problems associated with footstep noise.

.2 Definitions

The following are definitions of common parameters used to describe the acoustic characteristics of building environments, materials and assemblies:

- Sound Transmission Class (STC): a single number rating of the sound transmission loss properties of a wall, floor, window or door. A good reference for wall and floor STC ratings is the Alberta Building Code.

- Ceiling Attenuation Class (CAC): a single number rating that indicates how well suspended ceiling systems attenuate airborne sound between two rooms having a common plenum.

- Noise Reduction Coefficient (NRC) – a single number rating indicating the sound absorptive properties of a material ranging from 0.01 (negligible absorption) to 0.99 (very high absorption). Manufacturers of ceiling boards, wall panels and various sound absorptive finishes will usually list the NRC rating in their product information.

- Room Criteria (RC) – a rating method for HVAC system noise used to establish design goals and evaluate field installations.

- Reverberation Time (RT) – an indication of the persistence of sound in a room, measured in seconds. RT is dependent on the volume of the space and the sound absorptive properties of the room surfaces.

.3 Design Guidelines

- Classrooms

  The following guidelines are applicable for typical classrooms:

  - Reverberation in unoccupied classrooms shall not exceed RT 0.6 seconds, averaged over the frequency range of 500 Hz – 2,000 Hz.

- Acceptable reverberation time can typically be achieved by specifying a ceiling with a minimum NRC 0.55. Wall surfaces should generally remain hard to promote the distribution of speech throughout the room.

- Consider carpet to reduce distracting noises caused by movement of chairs and desks.

- Avoid classrooms with high or vaulted ceilings. Classrooms with ceilings higher than 3m, require additional acoustic treatment on the walls to achieve the RT criterion.

- Avoid highly elongated classrooms.

- Open plan classroom designs are strongly discouraged. It is not possible to provide sufficient sound isolation between open plan classrooms to achieve an acceptable learning environment.

• Gymnasium

  - Provide acoustic treatment on both the ceiling and walls to control noise and reverberation.

  - Reverberation in a typical unoccupied gymnasium should not exceed RT 2.0 seconds, averaged over the frequency range of 500 Hz - 2,000 Hz.

  - Acoustic treatment on the ceiling is most beneficial for general noise control. Select ceiling treatments with a minimum NRC 0.70.

  - Consider the use of acoustic roof deck, impact resistant acoustic ceiling panels or suspended baffles.

  - Acoustic spray-on material can also be used as a ceiling finish if the abuse resistant properties (adhesion, cohesion) of the product are suitable for this environment.

  - Do not use glue-on ceiling tiles.

  - Wall treatment should be distributed over at least two adjacent walls. Select wall treatment with a minimum NRC 0.70.

- Acoustic wall treatment is especially beneficial when placed on the rear wall (opposite stage) if the gymnasium is used for drama or musical events.

- Extend acoustic wall treatment as low as practical.

- Consider the use of impact resistant wall panels or acoustic concrete block.

- Ensure acoustic concrete block are specified to meet the minimum required NRC 0.70, to avoid problems with selective frequency absorption.

* Music Rooms

  - Avoid locating music rooms next to gymnasia, classrooms or other noise sensitive rooms.

  - Locate non-critical spaces such as corridors and instrument storage rooms around music rooms to provide a buffer.

  - Consider designing music rooms with two or three exterior walls to minimize sound transmission to other instructional areas.

  - Reverberation Time in a typical Music Room should be between RT 0.70 - 0.80 seconds, averaged over the frequency range of 500Hz - 2,000Hz.

  - Consider a ceiling height of 4m - 5m. Unlike classrooms, music rooms benefit from additional volume.

  - Avoid concave ceiling profiles or domes.

  - Consider making portions of the ceiling reflective to promote sound diffusion and ensemble between musicians.

  - Consider pyramidal or convex ceiling diffuser panels set into the T-bar grid covering approximately 10% - 20% of the ceiling.

  - Consider non-parallel sidewalls or provide sound diffusing elements on sidewalls such as open instrument storage.

- Where the instructor's teaching position is fixed because of risers, the wall behind the instructor should have acoustic wall treatment.

- Acoustic wall treatment should have a minimum NRC 0.80.

- Practice Rooms

  - Consider manufactured, modular practice rooms as an alternative to built-in place construction. Practice rooms require many specialized acoustical, mechanical and architectural construction details to function effectively.

  - Locate practice rooms, where possible, so they do not open directly into a music room. Consider using corridors or vestibules as a buffer.

  - Provide acoustic ceiling with minimum NRC 0.80.

  - Provide acoustic wall treatment with minimum NRC 0.80, distributed over approximately 50% of the total wall area.

  - Provide insulated metal or solid core door with acoustic door seals.

- Offices

  - Provide a ceiling with a minimum NRC 0.55.

- Common Areas

  - Corridors and lunchrooms require a ceiling with a minimum NRC 0.55.

  - Student gathering areas require acoustic ceiling treatment with a minimum NRC 0.70 to control the high noise levels that can occur in these spaces. Consider suspended ceilings, baffles, acoustic deck or spray-on materials.

  - Student gathering areas with extensive skylights require additional acoustic wall treatment to compensate for the lack of ceiling absorption. Provide a corresponding area of acoustic wall panels with a minimum NRC 0.70.

- Computer Labs

  - Provide ceiling with minimum NRC 0.70.

- Drama Theatre

  - Large theatres used for drama presentations have numerous acoustical requirements and should be reviewed by an acoustical consultant.

.4 Interior Walls

- Sound Isolation

  - Use the following table as a guide for determining minimum wall sound transmission loss requirements. Refer to the Alberta Building Code A 9.10.3.1 to assist in selecting wall assemblies that meet the STC requirements.

Space	STC
Classrooms	50
Offices	45
Lunch Rooms	55
Music Rooms (Elem.)	60
Music Rooms (Jr./Sr.)	65
Drama Rooms	55
Washrooms	55
Computer Labs	50
Libraries	50
Practice Rooms	60
Gymnasium	60

  - Provide full height construction for all walls with a rating of STC 50 or greater.

  - Full height construction is also preferred for wall assemblies with STC 45 rating. When this is not possible, extend wall 150 mm above the suspended ceiling and specify acoustic ceiling board with CAC 40 rating.

  - Provide a double plumbing wall between washrooms and instructional space. Ensure structural separation is maintained between each wall and specify that piping is attached to studs on washroom side only.

  - Prepare details that show the acoustic treatment at building component junctions, (e.g., partition on metal deck). The objective is to provide a continuous, airtight seal at all junctions.

- Avoid continuous drywall bulkhead construction between classrooms. Provide a complete structural discontinuity of the bulkhead at all common walls between classrooms.

- Provide a complete air-tight seal around piping, duct and conduit penetration through walls.

- Use massive wall construction (e.g. concrete block) around areas that produce high levels of low frequency sound such as mechanical rooms and gymnasia.

- Do not locate duct shafts in classrooms.

- Avoid locating doors in the common wall between classrooms. Where this is necessary, consider double doors with full perimeter acoustic seals.

- Operable partitions will not generally provide sufficient sound isolation for adjacent classrooms to function without interruption. If moveable walls must be provided, specify products with a minimum STC 50 and follow installation procedures described in ASTM E 557, Standard Recommended for Architectural Application and Installation of Operable Partitions.

.5 Site Planning

- Assess the noise impact of nearby major arterial roads, highways and airports.

- Orientate the school and locate instructional space to minimize the impact of traffic noise on classrooms.

- Design building envelopes, to reduce traffic noise in classrooms to a maximum hourly Leq of 35 dB(A). An acoustic consultant should review noise assessment and abatement techniques.

- Do not locate classrooms so that exterior windows are exposed to busy loading docks.

.2 Hazardous Materials

.1 General

- Prior to purchasing a property, hire an experienced environmental consultant to complete a Phase II Environmental Site Assessment (ESA), including some testing of suspected asbestos materials to make sure the site is not contaminated.

- For existing facilities a hazardous materials audit should occur.

- When selecting interior finish materials and products avoid the potential for off gassing wherever possible.

- When there is any concern or doubt about an existing material, it should be considered as potentially harmful (i.e. preventative caution and possible testing).

- Refer to Alberta Infrastructure Technical Bulletin No. 20 (latest edition) for Asbestos Materials. Available from Property Development, Alberta Infrastructure.

- Consider the following:

  - Asbestos
  - Chlorofluorocarbons (CFC's)
  - Chemicals such as water treatment solutions, glycol, cleaning solutions and laboratory chemicals.
  - Lead in batteries, paint, etc.
  - Mercury such as in switches and thermostats.
  - Polychlorinated Biphenyl's (PCB's)
  - Radioactive components such as in smoke detectors.

2.6 Building Site Work

.1 Site Services

.1 General

- References

  - Geometric Design Standards for Canadian Roads and Streets, by the Roads and Transportation Association of Canada.

  - Alberta Environmental Protection:

- Standards and Guidelines for Municipal Water Supply, Wastewater and Storm Drainage Facilities
- Stormwater Management Guidelines

- Propane Installation Code – CAN/CGA – B149.2.

- Uniform Traffic Control Devices for Canada, by the Council on Uniform Traffic Control Devices for Canada.

- Local municipal standards, guidelines and by-laws.

- Canadian Standard Association (CSA)

- ***Flood Risk Management Guidelines***, by Alberta Infrastructure

- Site Selection

  Prior to acquiring a property:

  - Confirm site is suitable for proposed development as per the Attached Table A in Appendix B. For a copy of the "Flood Risk Management Guidelines" contact Alberta Infrastructure.

  - Complete or review existing Environmental Site Assessments (ESA) to determine environmental liability of site.

  - Contact Alberta Community Development to find out is there any archaeological restrictions for this site.

  - Confirm that site and development is at an acceptable distance from high voltage power lines.

  - Confirm if direct or indirect access to a highway is required and if adequate road access is available to the site.

  - Confirm if a Traffic Impact Assessment (TIA) is required and if Public Transportation is available and adequate.

- Proposed development must be in compliance with planning/zoning requirements. Confirm need for stormwater management on site.

- Confirm that site topography is suitable for the project.

- Confirm availability of offiste services such as power, water, sanitary, storm and natural gas.

• Site Survey Plan and Site Plan

  - Conduct site survey and prepare a site survey plan if required.

  - From the information on the site survey plan, include the following items on the site plan in the contract documents:

    - Legal description and address of the property, property lines and their legal dimensions, and legal pins.

    - Adjacent trees, sidewalks, roadways, utilities, easements and how the new development will tie to them.

    - Work of the contract and work by other forces and contracts.

    - Main floor elevations and geodetic datum and the equated elevation.

    - All utilities, including power and telephone.

• Site Access

  - Design the location of site access in consideration to driveways and intersections adjacent to and opposite the site.

  - Provide a separate drop-off area for use by buses and passenger vehicles.

• Site Signs

  - Determine the locations of signs with due consideration to vehicular sight lines.

- Site Grading

  - Grade site to a minimum of 2% to drain surface water away from buildings and sidewalks.

  - Maintain minimum grade of 1% for concrete and asphalt surfaces.

  - Maintain minimum grade of 2% for graveled surfaces.

  - Provide roadways with a 2% crown or crossfall.

  - Address potential ponding and icing problems associated with downspouts. Provide splash pads under downspouts.

- Roads, Walks and Parking

  - Design driveways and off-site walks to meet local municipal standards.

  - Provide barrier free access walkways, entrances and parking spaces, along with appropriate transitions and surfaces that do not restrict the mobility of physically disabled people.

  - Lay out parking lots and locate parking fixtures to facilitate snow clearing, removal or storage and to avoid damage from snow moving equipment.

  - To address a potential safety concern, efforts should be made to separate main vehicular traffic from the main pedestrian traffic. Playground is not to be accessible through parking areas nor passenger drop-offs.

  - Design for snow dumping areas to reduce snow removal and storage requirements.

  - Do not obstruct parking lot user access to electrical plug-ins.

  - Provide a pavement structure cross-section for parking and roadways with a minimum 75 mm of asphalt.

- For parking lots where heavy trucks are anticipated, design pavement structure based on traffic projections and the California Bearing Ratio.

- Provide protective concrete sealers on concrete walks located in prominent areas where de-icing agents will be used.

- Provide a concrete pad for garbage bin and recycling bin, and locate bin for ease of access and safety.

- Provide an area for bike racks.

• Utilities

- Provide dimensions of utilities to property lines or use a grid coordinate system.

- Where utilities are to be connected to municipal systems, confirm with municipalities and utility companies the adequacies of their systems to service the site.

- Prior to school's expansion, check existing capacity of utilities for adequacy.

- Early in the design, confirm with municipalities about any restrictions on stormwater discharge to their stormwater drainage system.

- Contact the local municipality to confirm the existing municipal water pressure, and fire flow capacity. Determine whether on-site boosting is required for a fire sprinkler system.

- On large sites, locate utilities in utility corridors, keeping in mind any potential for future development.

.2 Landscape Development

.1 References

• **Alberta Agriculture, Food and Rural Development, *Alberta Yards & Gardens, What to Grow***

• **Alberta Agriculture, Food and Rural Development, *Pruning in Alberta***

- **Alberta Infrastructure, *Manual for Maintenance of Grounds***

- Local municipality landscape requirements.

- Canadian Standards Association (CSA).

.2 Exterior Landscape Development

- Include municipal boulevards in the landscape design and construction.

- Retain as many trees on site as feasible; protect trees and their roots by hoarding. Maintain existing grades to the drip lines of trees, or provide tree wells to compensate for change in grades. Remove any existing tree from site that is considered a hazard to property and public safety.

- Grade topsoil to drain surface water away from buildings and walkways. Provide positive drainage within tree pits having a tree grate covering.

- Consider ease of maintenance and safety in all design aspects.

- In grass areas, provide enough distance between trees and other features to accommodate cost effective mowing equipment. Avoid sharp angles and tight spaces that would make maneuvering mowers difficult.

- Space all plants at no less than 60% of mature spread.

- Keep tops of berms free of trees, shrubs and plant beds.

- Design slopes, including grassed berms, at less than 3:1 and free from hazardous maintenance requirements.

- Design all planters to have minimum planting width of 1.5 m, with minimum 300 mm depth of gravel for drainage and minimum 600 mm depth of soil mix. Provide weeping holes at planter bases.

- Consider soil conditions and site location when selecting plant material and grass seed mixtures for use. Use plants consisting of varieties that are indigenous to the locality.

- Use plant material to screen schools from busy roads and highways or visually distracting activities.
- Use earth berms to form visual barriers and screening from noise and undesirable views.
- Consider raised planting areas in paved areas to reduce maintenance and provide places to sit.
- Do not obscure exterior lighting and school name sign with plants.
- All grass areas around the school building shall be sodded. Use proper grass seed mixtures on all other areas.
- Provide adequate maintenance for all plants and grass areas until established.

.3 Planting Near Buildings and Utilities

- Provide mulches for dry areas under building overhangs. Do not design these areas for plants.
- Locate shrubs at least 750 mm from foundations and edges of sidewalks.
- Select small trees or high shrubs with a mature height of 3 m, for areas within 15 m of any overhead utility.
- Do not locate trees within the immediate vicinity of underground utility lines.

.4 Interior Landscape Development

- Provide gravel for drainage in all planting areas and planters.
- In atria, ensure access for maintenance requirements.
- Provide adequate lighting conditions to meet requirements of selected interior plants.
- Provide interior hose bibbs every 15 m along building walls in atria.
- Use high quality artificial plants in buildings where maintenance of live tropical plants is difficult or poor lighting conditions exist.

.5 Environmental and Conservation Considerations

- Design to minimize maintenance requirements. Consider mowing, trimming, pruning, fertilizing, pesticide application and general clean-up requirements.
- Use mulches to reduce maintenance and watering requirements for trees and shrubs.
- Minimize the requirement for irrigation through selection and placement of plant material.
- Minimize mowed grass areas. Use low maintenance ground cover plantings, including low maintenance grass mixes, where appropriate.
- Use plant material to reduce heating and cooling requirements for buildings.
- Use plant material to control snow drifting.

.6 Playgrounds and Sports Fields (not funded by Alberta Infrastructure)

- Design and construct children play areas and equipment to standards established by Canadian Standards Association (latest edition Z614-98).
- Locate playgrounds that are visible from inside the school building.
- Design and construct sports field facilities to standards established by the various associations and municipal requirements.

2.7 Mechanical

.1 General

.1 References

Comply with all applicable codes, regulations and standards.

- Canadian Standards Association
  - CSA-B51 Boiler, Pressure Vessel, and Pressure Piping Code
  - CAN/CSA-B52 Mechanical Refrigeration Code
  - CAN/CSA-B139 Installation Code for Oil Burning Equipment

- CAN/CGA-B149.1 Natural Gas Installation Code

• Alberta Building Code

• Alberta Fire Code

• National Fire Protection Association Standards

  - NFPA 10 Portable Fire Extinguishers
  - NFPA 13 Installation of Sprinkler Systems
  - NFPA 14 Installation of Standpipe and Hose Systems
  - NFPA 51 Design and Installation of Oxygen-Fuel gas Systems for Welding, Cutting and Allied Processes
  - NFPA 90A Installation of Air-Conditioning and Ventilation Systems
  - NFPA 96 Ventilation Control and Fire Protection of Commercial Cooking Equipment
  - NFPA 664 Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities

• National Plumbing Code of Canada

• Alberta Occupational Health and Safety Act

  - Ventilation Regulation
  - Chemical Hazards Regulation

.2 Refer to the following references for guidance:

• ASHRAE Handbooks

• ASHRAE Standards

  - ANSI/ASHRAE 55 Thermal Environmental Conditions for Human Occupancy
  - ANSI/ASHRAE 62 Ventilation for Acceptable Indoor Air Quality.
  - ASHRAE/IESNA 90.1 Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

• ACGIH Industrial Ventilation: A Manual of Recommended Practice

• SMACNA Standards

• Model National Energy Code of Canada for Buildings

.3 General

- Use life cycle costing when evaluating system alternatives.

- Ensure sufficient space and access are provided around mechanical equipment for safety, ease of maintenance and future component replacement (tube bundles, coils, filters, motors, etc.)

- Prepare contract drawings with schematic diagrams indicating the following:

  - Mechanical systems, major equipment and components.

  - Equipment, components, piping and ductwork, arranged to accurately reflect the physical (on-site) configuration including equipment connections, valves and dampers.

  - Devices that measure air and water flow, temperature, and pressure.

- Provide painting and identification systems on mechanical piping, ducting and equipment. Consider Alberta Infrastructure Colour Coding Requirements as a reference.

- Provide balancing for all applicable systems. Consider directly hiring the balancing agency by the School Board.

.4 Design Criteria

- Design mechanical systems based on the criteria set out below and in Table 2.7-1.

- Special building areas may require different conditions than those outlined. Document these conditions and make allowances in system design.

- Base heating design on outdoor ambient temperatures given in the Alberta Building Code.

  - Outdoor Temperature – January 1% value

- Minimum indoor design requirements:

-	Indoor Temperature	22^{o}C
-	Relative Humidity	30% at 0^{o}C 15% at –35^{o}C

- Filter Efficiency — 30% based on ASHRAE 52
- Outdoor Air Requirements — Refer to Table 2.7-1
- Total Air Changes per Hour — Refer to Table 2.7-1
- Relative Pressurization — Refer to Table 2.7-1
- Noise Level — Refer to Table 2.7-1

Table 2.7-1 Mechanical System Design Parameters

Space	Outdoor Air Requirements (1)		Total Air Changes Per Hour	Relative Pressurization (2)	Noise Level RC(N) (3)	Remarks
	L/s Per Person	L/s per M^2				
Auditorium	8		12*	E	20 – 25	* Based on 3 m height space.
Cafeteria	10		12	-	40	
Classrooms	8		6*	E	25 – 30	*Minimum 22.81 L/s/M2 of supply air.
Computer Rooms	8		12	E	35	
Conference Room	10		10	E	30	
Corridors		0.5	4	E	40	
Gymnasium	10		6	E	35	See note (4) below.
Home Economics	8		*	-	30	* Air changes to satisfy exhaust demand.
Industrial Arts	8		*	-	35	* Air changes to satisfy exhaust demand.
Kitchen	8		12	-	45	
Laboratories	10		10	-	30	
Library	8		6	E	30	
Locker Rooms		2.5	10	-	45	
Music Room	8		8	E	30	
Office	10		6	E	35	
Reception	8		6	E	35	
Server Room	10		8	E	45	(See note (5) below.
Staff Room	10		8	-	40	
Storage Rooms		Optional	4	-	45	
Washrooms		Optional	12	-	45	

Notes:

1. **Outdoor air requirements to meet ASHRAE 62 – Multiple Spaces.**
2. **E denotes equal or neutral relative pressure to surrounding spaces. - denotes negative relative pressure to surrounding spaces.**
3. **Number indicates acceptable range or maximum level of background noise in terms of room criteria (RC) assuming a neutral (N) spectrum.**
4. **Gymnasium normal occupancy 30 to 50 students for outdoor air requirements. Peak (maximum) to be reviewed with school board, i.e. 250 plus. Air changes to be based on 3 m height, i.e. occupied zone.**
5. **Provide mechanical cooling to offset internal heat gains as required.**

Alberta
Infrastructure and Transportation

.5 Energy Performance Objectives

- Design all aspects of educational facilities in accordance with energy standards. Consider the Model National Energy Code of Canada for Buildings as a guide.

- Design facilities with gross area over 10,000 m^2 to operate below target Building Energy Performance Index (BEPI) figure.

- For facilities with a gross area less than 10,000 m^2 an energy analysis simulation is normally not required. However, when designing facilities larger than 10,000 m2 an energy analysis is to be submitted for review.

- Develop energy conservation and heat recovery options and discuss with the regional school board for evaluation and approval. Consider energy conservation and energy cost avoidance options that are supported by economic cost analysis. Options that should be considered are:

  - free cooling
  - heat recovery and reclaim
  - reduced fan and pumping systems when maximum flow is not required
  - reduced outside air volumes and ventilation rates during unoccupied hours
  - lower space temperature during unoccupied hours.
  - shut down fans and domestic water recirculation pump during unoccupied hours
  - load shedding

- Implement energy conservation and energy cost avoidance options when the pay back (including financing) is ten years or less.

- Specify high efficiency motors in accordance with CSA 390, Energy Efficient Test Methods for Three-Phase Induction Motors.

.6 Target Building Energy Performance Index (BEPI)

- The Building Energy Performance Index (BEPI) indicates the amount of energy consumed annually, per unit area, and is defined as:

$$\frac{\text{Building Energy Requirements (MJ)}}{\text{Building Area (m}^2\text{)} \bullet \text{1 year (a)}} = \frac{\text{MJ}}{\text{m}^2 \bullet \text{a}}$$

Alberta
Infrastructure and
Transportation

- The target maximum BEPIs is 900 $MJ/m^2 \cdot a$.

.2 Heating

.1 General

- Design the heating plant to maintain comfort conditions as outlined in Clause 2.7.1.4, Design Criteria.

- A primary objective of the heating systems design is to ensure that the operating and maintenance of the system is as simple as possible. Complex, multi-temperature, multi-loop systems should be avoided. ‘

- Select equipment to provide an adequate level of redundancy and reliability taking into account the heating load profile, thermal energy storage, and the availability of spare parts for servicing equipment.

- The optimum system is a central boiler plant complete with hot water distribution system. This does not preclude other options; however, other systems should only be implemented based on sound and clearly identified benefits.

.2 Boilers

- Establish the capacities, arrangement and number of boilers such that when any one boiler is out of service, the remaining boilers shall be sufficient to offset building transmission heat loss. Note this excludes heat for ventilation.

- Select boiler sizes to provide the maximum operating efficiency and cost effectiveness for each facility. Consider full modulating burner controls in all boiler sizes where available.

.3 Heating Distribution

- Preference should be given to the two-pipe reverse return system for heating water piping. Two-pipe direct return system may be used only if the design properly guards against flow imbalance to terminal units, and it is a small part of a reverse return system.

- Consider primary-secondary pumping only where it will reduce power consumption and provide better control.

- Consider parallel pumping with a minimum of two circulation pumps each rated at 50% of system capacity.

- Provide means of isolation, balancing and flow measurement at major pieces of equipment and major circuits.

- Provide isolation valves on supply and return mains, and risers.

- Use variable speed pumps where justified by cost or control to maintain required system pressures when variable flow distribution systems are provided.

.4 Heating Terminals

- Ensure heating terminals are easily accessible for inspection and cleaning.

- Valve each terminal at the supply and return connections. Balancing valve must be provided at each terminal unit.

.5 Heating Systems

- General

  - Select systems on the basis of maintainability, controllability and life-cycle costs.

  - Provide individual thermostatic zoning for each instructional space.

  - Design perimeter heating and ventilation to prevent cold interior surface temperatures on glazing.

  - Provide cleaning, degreasing and chemical treatment on hot water heating system.

- Finned Radiation

  - Where finned radiation is used behind millwork ensure there is access for cleaning.

- Radiant Panel Heating
  - Consider architectural details, window covering and any perimeter air supply outlets in the use of radiant panel heating systems. Use radiant panel heating only where the panel width can be limited to 600 mm or less and the glazing is completely exposed to the radiant effect of the panel.
  - Radiant panels may be used in all areas of an educational facility where the heat loss of the room can be offset by the radiant panels.
  - Use radiant panels where perimeter furniture and cabinets prevent the use of radiation.
  - Use special care in locating radiant panel thermostats. The radiant panel shall be scheduled on before the air system reheat coil.
  - Radiant panel loop water temperature should not be scheduled so low as to adversely affect the performance of the panel, when combined with another heating system.
- Heat Pumps
  - The use of heat pumps should only be considered where all other options have been reviewed as non-viable. Issues such as maintenance, operating costs, filtration and noise must be reviewed with the school board. Locate units outside instructional spaces.
- Gymnasium Heating
  - Heating system for gymnasium shall be independent from gymnasium ventilation system.
- Domestic hot water heating should be independent of the building heating system.

.3 <u>Ventilation</u>

.1 General

- Design air handling systems to maintain environmental conditions in accordance with the design requirements as outlined in Table 2.7-1.

- Zone air systems in accordance with space function and occupied hours. Provide separate unit for gymnasium. Consult with school board regarding other special areas that may require separate air units.

- Design air-handling systems to provide free cooling, utilizing outdoor air when ambient conditions permit.

- Where constant volume air systems are used, consider reheat requirements for interior zones.

- Provide exhaust systems to remove odors, smoke, fumes or heat.

- Provide ventilation and heating to crawlspace.

- Clean new and existing ductwork and air handling equipment when project involves modernization of school facilities.

- Do not use mechanical rooms as air plenums.

.2 Air Handling Equipment

- To facilitate maintenance, indoor equipment is preferred.

- Provide plenums with hinged, sealed access doors for access to all components. Provide windows and lighting for inspection of each chamber.

- Provide an economizer section with outside air, return air and exhaust air dampers arranged to provide good mixing of the air streams.

- For proper operation of the economizer section and, to maintain space static pressure control, provide a return air fan whenever air is to be returned to air handling equipment.

- Generally, individual room unit ventilators are not acceptable for schools and are only to be considered when other options prove not viable.

- Use factory manufactured air blenders to prevent air stratification and provide uniform flow across coil.

- Use a 50:50 mixture of glycol and water in preheat coils.

- Provide summer and winter filter locations where frost may occur.

- Locate outdoor air intakes away from ventilation exhausts, chimneys, plumbing vents, vehicle exhaust and ground contaminants.

- Use high modulation capacity burner where gas fired heat exchangers are provided.

- Where spaces are heated with radiant heating panels or radiation, do not use an on-off gas fired heating and ventilating equipment to serve such multiple spaces. Unacceptable temperature swings will result with these systems.

- Gymnasium space has wide variance in occupancy. Provide reduced outdoor air volume for normal versus peak occupancy. Consider reduced air movement for normal versus peak occupancy. Provide selector switch for normal/high system operation. Consider CO_2 sensors or alternate design to balance outdoor air supply rate with space occupancy.

.3 Humidification

- To minimize health risks associated with low humidity, provide humidification systems to meet design criteria. Reference ASHRAE Handbook ‘Systems and Equipment - Humidifiers’.

- Use steam humidifiers in air handling systems. This does not preclude other options which should take into account other systems within the school district where maintenance and familiarity are important considerations.

- Consider gas fired steam boiler or individual gas fired steam humidifier.

- Electrode and electrical steam generators for humidification should only be considered when the humidification load is less than 45 kilograms steam per hour.

- To control mineral scaling, provide appropriate water treatment systems for humidifiers’ feed-water.

.4 Zoning

- Zone air systems in accordance with space function, occupied hours, and air quality requirements.

- Where areas with different operating schedules are served by one air-handling unit, provide a means of area isolation to reduce air flow and energy use.

.5 Distribution

- Ensure that good air distribution and occupant comfort are achieved through appropriate air outlet application, selection and location.

- Provide adequate access for internal inspection and cleaning of all ductwork.

- Duct all exhaust air systems. Do not use ceiling space or mechanical rooms as exhaust air plenums.

- Use corrosion resistant materials for exhaust ducts conveying corrosive fumes and vapours, or where condensation is likely to occur.

.6 Exhaust and Equipment Discharges

- Locate exhausts from the following areas and equipment discharges away from any intake, building opening or occupied space:

  - industrial arts, home economics and laboratory areas
  - cooling towers
  - boiler stacks
  - generators
  - kitchen and washroom exhaust

- Consider the effects of winds in selecting the location of all discharges and air intakes.

.7 Variable Air Volume (VAV)

- Consider VAV only for systems where the supply air volume will modulate below 85% of design air volume. Provide variable frequency drives.

- Ensure minimum outdoor air supply is maintained at all times during school hours in accordance with Table 2.7-1.

- Sequence radiation and VAV boxes on the same temperature sensor, except for radiation elements within ceiling space.

.8 Rooftop Units

- Provide protection for unit from vandalism, i.e. screen, padlocks on doors.

- Locate rooftop equipment over corridors or other non-critical areas. Avoid placing equipment over instructional space.

- Where a continuous roof surface is to be maintained below equipment (i.e. no roof curb), provide supports to maintain a minimum of 1.0 m clearance below the equipment.

- Consider enclosed heated service corridor wherever practical when rooftop units are used.

.9 Special Ventilation Systems

- Kitchen

  - Provide exhaust with make-up air and maintain negative pressurization in space during cooking periods. Consider reducing air flows during non-cooking periods to conserve energy.

- Career Technology Studies (CTS)

  - Provide exhaust from fume and odor producing equipment and activities, i.e., welding, photo laboratory, plastic processes, silkscreen, etc., generally in accordance with the recommendation from the manual for industrial ventilation.

  - Provide make-up air and maintain negative pressurization for CTS, industrial arts and home economics areas.

  - For woodworking areas provide dust collection equipment that maintains a safe working environment, particularly with respect to noise and exposure to wood dust. Refer to Occupational Health & Safety publication “Health Effects from Exposure to Wood Dust” for guidance.

  - Provide only non-recirculating dust collectors. Install dust collectors outside of the school.

- In cases where a recirculating dust collector is the only option, ensure NFPA requirements for explosion and fire protection are addressed.

- Science Laboratories

  - Where a fume hood is required, provide fume hood with vented chemical storage and associated stainless steel exhaust duct system in science laboratories and science preparation rooms. To conserve energy, consider two speed fume hoods.

  - Provide make-up air and maintain negative pressurization for these rooms.

  - Specify fume hoods with a factory supplied face velocity monitor and alarm.

.4 Cooling

.1 General

- Consider cooling only where absolutely necessary to maintain health and comfort conditions.

- Use outdoor air for free cooling when ambient conditions permit.

- Base cooling design on outdoor ambient temperatures given in the Alberta Building Code.

  - Outdoor Temperatures – July 2.5% Values

.2 Refrigeration Equipment

- Design refrigeration systems in conformance with CSA/CAN-B52 Mechanical Refrigeration Code.

- Use direct expansion refrigeration in air conditioning systems less than 100 kW of refrigeration. Capacity control to be provided by staged compressors and split row coils.

- Chilled water cooling is preferred for all systems over 100 kW of refrigeration.

- Avoid use of reciprocating refrigeration in systems over 700 kW of refrigeration.

.3 Chiller Sizing

- Size chiller on the calculated requirements, diversity factor, and load profile. Do not apply any safety factor for sizing chillers.

.4 Cooling Distribution

- Preference should be given to the two-pipe reverse return system for cooling water piping. Two-pipe direct return system may be used only if the design properly guards against flow imbalance to terminal units, and it is a small part of a reverse return system.

- Provide means of isolating, balancing and flow measurement at major pieces of equipment and major circuits.

- Use variable speed pumps where justified by cost or control to maintain required system pressures when variable flow distribution systems are provided.

.5 Cooling Systems

- Use Table 2.7-2 as a general guide in determining the type of cooling system to be used:

Table 2.7-2 Cooling System Guidelines

Cooling Load (kW)	Cooling Medium	Heat Rejection Equipment	Compressor Type	Additional Information
105 or less	Refrigerant	Air cooled condenser	Scroll or, reciprocating hermetically sealed	Maximum compressor size 7.5 kW power. Split row evaporator coil
105 to 705	Chilled water	Air cooled condenser, air cooled chiller. Evaporative cooling tower.	Rotary screw. Centrifugal, or rotary screw.	
Greater than 705	Chilled water	Evaporative cooling tower.	Centrifugal	

.5 <u>Plumbing and Drainage Systems</u>

.1 Plumbing Piping Systems

- Domestic Water Service

- Provide domestic hot water recirculating piping complete with balancing valves where hot water supply piping exceeds 15 m. Branch piping from a fixture to a recirculated main shall not exceed 8 m.

- As a minimum provide duplex gas fired water heater installation.

- Provide non-freeze key operated hose bibbs every 30 m at the building perimeter.

- Do not exceed 2.0 m/s velocity for cold water piping and 1.2 m/s for hot water supply and recirculating piping.

- Provide backflow prevention to plumbing code requirements.

• Sanitary Sewer Piping System

  - Provide appropriate traps or interceptors for sinks in areas such as hair dressing, art room and CTS.

• Storm Drainage System

  - Avoid use of controlled flow roof drainage.

  - Provide minimum 100 mm roof drains.

  - Provide a minimum two roof drains per drainage area.

  - Direct flow that is discharged at grade so that it does not flow onto areas for pedestrian or vehicle traffic, where it could freeze and become a safety hazard, or onto areas where it could cause erosion damage.

  - Terminate roof drain exterior discharge outlet with an elbow at least 1.0 m above grade. Provide a thermostatically controlled immersion heater from the discharge back into the building to prevent freeze-up during the winter.

• Laboratory Drainage System

  - Provide small laboratories or isolated laboratories with point-of-use dilution or neutralizing traps.

.2 Plumbing Fixtures

- General

  - Consult with the school board as to appropriate fixture and trim types. Consider the following general approach:

    - Use floor mounted water closets.
    - Use flush valves in student washrooms.
    - Use metered faucets in student washrooms.
    - Use stainless steel sinks for student washrooms and classroom sinks.
    - In washrooms consider electronic fixtures for hygienic and water conservation reasons.
  - Provide refrigerated drinking fountains.
  - Provide a tempered water supply to shower fixtures, student washrooms and emergency eyewash.

.6 <u>Fire Protection</u>

.1 General

- Design fire and life safety systems in accordance with the requirements of the Alberta Building Code.

- Generally, to avoid having partially sprinklered schools, when a sprinkler system is to be installed it should be installed throughout the school. Coordinate requirements with the local fire authority.

.2 Sprinkler Systems

- Design sprinkler systems in accordance with the Alberta Building Code and requirements of NFPA 13.

- Ensure inspector's test point is piped to the exterior or to drain.

.3 Standpipe and Hose Systems

- Design standpipe and hose systems in accordance with the Alberta Building Code and requirements of NFPA 14.

.4 Portable Fire Extinguishers

- Provide portable fire extinguishers in accordance with the Alberta Building Code and requirements of NFPA 10.

.7 Noise and Vibration Control

.1 Background Noise

- Refer to Table 2.7.-1, Mechanical System Design Parameters for acceptable HVAC noise levels listed in terms of RC.

.2 HVAC Noise

- Whenever possible, design the system layout so that any medium velocity ducts and terminal boxes are in non-instructional areas such as corridors.
- Provide details describing acoustic treatment, duct configuration and roof penetrations for any rooftop installations.
- Use masonry construction for large mechanical shaft walls that are common to occupied areas.
- Locate silencers within mechanical rooms as close as possible to the mechanical room wall. For walls that are not fire-rated, a portion of the silencer should penetrate the wall.
- Use flexible connections between fans, plenums and all related ductwork.
- Provide smooth airflow conditions near the fan units to minimize air turbulence. Large, rectangular ductwork with medium and high air velocities can create low frequency duct rumble. Spiral-wound, round duct is preferred for air velocities over 9 m/s or where excessive turbulence is anticipated.
- Use non-continuous perimeter heat cabinets that terminate at walls. Discontinue use of fins at all wall junctions. Provide for a complete airtight seal where the heating pipe passes through wall.

- Consider impact of mechanical noise on nearby residences. Silence or strategically locate outdoor mechanical equipment or intake/exhaust openings to meet local municipal noise by-law requirements. In the absence of a noise by-law, design systems to a maximum noise level of 50 dB(A) at the school property line.

- Select terminal box on basis of both induct and radiated noise level. Manufacturer's VAV box noise data often assumes the equipment is located above a mineral fibre suspended ceiling and the use of acoustically lined duct. Ensure that design conditions correspond with these assumptions.

- Select the NC rating of diffusers/air outlets so that the combined sound from all outlets meets the design criterion. For a typical classroom, the rating for each diffuser/outlet should not exceed NC 20.

- Locate balancing damper at least 2 m away from diffuser.

- Provide at least 1.0 m of flexible acoustic duct at diffuser inlet for instructional spaces.
- Do not use unit ventilators in classrooms unless the equipment has certified noise data indicating that the background noise criteria can be achieved at a distance of 1 metre from the unit.

- Locate furnaces outside of classrooms or in suitable closet to achieve specified background noise criteria in Table 2.7-1. Provide silencing of supply and return air from furnaces. Utilize acoustically lined plenum ducting or transfer ducts as applicable.

- Locate mechanical room or main air handling equipment away from instructional spaces or other noise sensitive areas.

- Avoid locating duct shafts in classrooms.

.3 Plumbing Noise

- Use a resilient sleeve around supply pipes with oversize clamps fastened to structure, in areas where water flow noise may be a disturbance. Sleeves comprised of 12 mm thick closed-cell elastomeric pipe insulation or proprietary resilient pipe fasteners are acceptable. Do not use hard plastic sleeves.

- Ensure that pipes penetrating through drywall partitions are not rigidly connected. Provide a sleeve at the wall opening, leaving an air space around the pipe, and seal with a resilient caulking.

- Where double plumbing walls are used (e.g. washrooms), attach supply piping only to the fixture side of the wall structure.

- Consider the use of pressure reducing valves (PRV's) in the system to minimize plumbing noise for noise sensitive areas. Size PRV's to limit the pressure at fixtures to 375 kPa.

- Install water hammer arrester adjacent to any quick-acting solenoid valves.

.4 Vibration Isolation

- Use the current ASHRAE Applications Handbook as a general guide for selecting vibration isolators and concrete inertia bases.

- Use flexible connectors on pumps requiring vibration isolation from related piping. Twin sphere neoprene rubber flex connectors are the preferred type.

- Locate rooftop mechanical equipment on a stiff portion of a lightweight roof to eliminate resonance problems. Vibration problems can usually be avoided if the static deflection of the spring isolator is at least 15 times the structural deflection of the roof caused by equipment loading. Co-ordinate with structural consultant.

- Locate emergency generators at grade level to avoid structural vibration problems.

.8 <u>Controls</u>

.1 General Requirements

- Use BACnet or LonWorks compliant distributed digital control (DDC) energy management control systems (EMCS) to:

  - control heating, ventilating and air conditioning systems.
  - execute control strategies to minimize energy consumption.
  - monitor and record mechanical systems' performance.

- provide dial out of alarm signals.

- Approve commercially available field proven systems that will be installed, engineered and commissioned by trained and qualified personnel, employed by companies that can provide an acceptable level of after service.

- Provide systems with user friendly interface and control language that allows user reprogramming of the control sequences. Provide program and graphics editing software including all required manuals.

- Create dynamic graphics in the central control unit (CCU) for all mechanical systems.

- Use terminal equipment controllers (TEC's) in new construction or in retrofits where majority of terminal equipment will be upgraded.

- TEC's should not be used for control of major equipment, i.e. boilers, air handling units, etc.

- Provide for offsite support access by including a modem or serial device server for telephone or internet connectivity.

.2 EMCS Design Objectives

- Develop a plan early in the project to define the requirements for:

  - contract documentation,
  - vendor acceptance,
  - product approval,
  - system field inspection,
  - customized control software, and
  - commissioning the EMCS.

.3 EMCS Operating Objectives

- Use custom control sequences and application programs to conserve energy by:

  - controlling primary energy consuming equipment.
  - deciding optimum start and stop times for equipment and systems that do not operate 24 hours a day.
  - resetting air and heating water supply temperatures using feed back from occupied space demand.

- resetting humidity from outside air temperature.
- using air systems to preheat, precool or purge to achieve the objective space temperature at the start of occupancy.
- control car plugs.

• Use custom control sequences and application programs to provide stable control by resetting heating water supply temperature using feedback from occupied space demand and outside air temperature.

.4 Field Devices

• Specify electrically powered actuators to drive all valves, dampers and other control devices, except that central equipment actuators may be pneumatically powered in extensions or renovations to existing facilities where pneumatic power of adequate capacity is available.

• Ensure that control valves are selected with flow characteristics to match the application. Size so as to maintain reasonably linear control characteristics.

• Consider the use of 1/3 and 2/3 sized control valves for coils with large load variations.

• Match the damper type, face area, power of actuator, and method of rod and damper linkage to give a linear volume control characteristic.

.5 Contract Documents

• Provide detailed requirements for:
  • O&M Manuals.
  • Operator training.
  • Central and Portable Control Stations.
  • Remote and Terminal Control Units including control language.
  • Field Devices, Conduit and Wiring.
  • Identification of Points, Devices and Wiring.
  • System Start-up and Testing including point verification and calibration.

• Provide schematics for each mechanical system showing specified control points.

• Provide point sheets listing all points to be installed. Group points on a per system basis. Refer to Alberta Infrastructure Standard for Logical Point Mnemonics when selecting point names.

- Provide detailed control sequences identifying the use or purpose of every specified control point.

- Use the Alberta Infrastructure Basic Master Specification sections 15910, 15911, 15912, 15913, 15914, 15916, 15917, 15941, 15942, 15956 as a basis for documents. If desired, updated DRAFT versions may be obtained from Technical Services Division, Manager, EMCS.

.6 Start-up, Testing and Point Verification

- Ensure the controls contractor verifies every physical point and submits check sheets showing all calibration values as well as actuator spans for pneumatic actuators.

- Ensure contractor submits trend data showing that all control loops have been tuned.

- Witness all start-up tests and perform Minister's point verifications as outlined under 15956.

.9 <u>Commissioning</u>

.1 Determine the commissioning requirements for each project based on complexity, size, cost, location, occupancy, unique client requirements, and consistent with the risks associated with system performance. Prepare and review commissioning plan with the school board.

.2 Verify the installation and test the performance of each major component and system, individually and collectively, to ensure the facility is complete, and functioning efficiently according to the design objectives and requirements.

.3 Provide documentation of verification and performance tests.

.4 Train building operators to operate and maintain systems, through formal seminars and demonstrations of equipment and systems.

.5 If required by client/consultant agreement, provide appropriate operation and maintenance manuals for use by the building operators. Include, on a system-by-system basis, design criteria, system information, operation procedures, maintenance requirements and shop drawings.

2.8 Electrical

.1 General

.1 Design to meet or exceed the following latest published standards:

- Canadian Standards Association and Underwriters Laboratories of Canada
- Illuminating Engineering Society of North America
- Institute of Electrical and Electronics Engineers
- Alberta Building Code
- Canadian Electrical Code
- Model National Energy Code of Canada for Buildings
- Local Regulations
- APEGGA GUIDELINE entitled Required Detail Content in Electrical Drawings and Specifications for Construction or Tender

.2 Provide a comprehensive single line diagram of the power distribution system as part of the contract documents complete with the following:

- Configuration, type, voltage, current ratings of all switchgear, transformers, panelboards and motor control centres (MCC's).
- Type, frame size, trip size, interrupting rating of all overcurrent protective devices.
- Available fault current at all switchgear, switchboards, panelboards and MCC's.
- Type, size and current ratings of services and feeders.
- Connected load and anticipated demand load at all switchgear, switchboards, panelboards and MCC's.

.3 Provide copies of "as-built" single line diagrams as part of the Operating and Maintenance Manuals.

.4 Provide copies of "as-built" single line diagrams framed and hung in each major electrical room with the equipment in the room highlighted.

.5 Equipment Rooms

- Locate main electrical distribution equipment in a separate room. The room to be large enough to accommodate electrical equipment and have space to accommodate future needs. The room to be adequately ventilated and illuminated and located as close as practical to major electrical loads. Provide floor mounted equipment with a housekeeping pad except for roll-out style switchgear.

- Indicate space for electrical rooms and closets on final block schematic submission.
- Panelboards and system cabinets should be located in electrical rooms or equipment closets rather than in public corridor walls. Avoid locating in storage rooms.
- Locate equipment rooms away from acoustically or electromagnetically-sensitive areas.
- Provide clear access to equipment rooms at floor level.

.2 Services and Power Distribution

.1 Electrical Service

- Consult with the School Board and the Utility to evaluate service options and rate structures and determine construction contributions, if required.
- Size main services and service transformers according to connected load or estimated load, whichever is greater. Add an allowance of 20% for future loads.
- Calculate connected load using demand factors as dictated by the type of load.
- Calculate estimated loads based on basic power loads plus additional loads anticipated for heavy power usage areas.
- Calculate basic power load due to lighting, general power, convenience loads and basic mechanical equipment, as follows:
  - Buildings Over 1,000 m^2 - 40 VA/m^2
  - Buildings Under 1,000 m^2 - 50 VA/m^2
  - Where the Building is to be Air Conditioned Add: 10 VA/m^2.
- Heavy power usage areas include kitchens, workshops, laboratories, computer labs and areas with large numbers of electrical equipment connections or receptacles. For these areas, calculate additional loads as follows:
  - Each Heavy Usage Area: 100 VA/m^2, or,
  - Connected load at 100% demand, plus
  - Other loads such as snow melting, block heater outlets, welders and electric heating.
  - Calculate additional connected load at 100% demand with a seasonal and workflow diversity factor applied.

- Power, telephone and cable television services shall unless impractical be routed underground from the Utility connection point to the consumers service equipment.

- Select service voltage according to the majority of load requirements, 120/208 volt or 347/600 volt, three-phase, 4 wire.

.2 Power Distribution System Protection and Control

- Ensure adequate fault duty ratings of all switchgear, panels, MCC's and overcurrent devices, verified by fault calculations.

- Ensure coordination of overcurrent and ground fault devices:

  - Conduct preliminary coordination analysis complete with consolidated time-current characteristic curves and single line diagram showing utility fault level and protection, main incoming and feeder devices.
  - Provide final coordination analysis documents before completion of construction to ensure proper functional coordination of all devices.

- Provide all services 1,000 A and over, and feeders sized 600 A and over, with ground fault protection. Coordinate ground fault protection of exterior circuits with main distribution detection to prevent a branch circuit fault knocking out the entire system.

- Do not provide single phasing or under voltage protection on main service device. If necessary, provide single phase protection for individual motors or group of motors.

.3 Switchgear, Switchboards and Panelboards

- Use molded case circuit breakers for all circuit protective devices except as follows:

  - Use industrial duty, drawout type air circuit breakers for services over 800 A.
  - Use solid state trip molded case breakers complete with trip mode indication for services sized 400 to 800 A.
  - Use high rupturing capacity fuses where fault duties of equipment require a limitation of the available fault current.

- Aluminum bussing is not recommended. Use solid copper for bussing sized 600 A and over.

- Provide microprocessor-based, digital AC metering device for services over 500 kVA with:

  - Meter to display true RMS values for phase voltage (line to line and line to neutral), phase currents, kVA, kVAR, kW, PF, Hz, MWhr, kWd and kVAd.
  - Meter to be field programmable via front key pad and RS232 and RS485 port.
  - Meter to have two programmable dry contacts.
  - Output and interface software for tie to building automation system. Capability for recording, load shed and alarm set points.
  - Size instrument transformers such that the initial design full load is approximately 60% of rating.
  - Provide PT and CT test blocks for each meter.
  - Meter to have RS232 and RS485 data output port.

- Do not use feed-through panelboards.

- Provide lifting equipment for all industrial type drawout air circuit breakers and stacked high voltage starters.

- Provide for all switchgear and MCC's a minimum of 1.5 m frontal clearance, in addition to space required for draw out equipment in full disconnect position. Provide all freestanding switchgear with a minimum of 1.0 m back and side clearance.

.4 Transformers

- Location:

  - Main Building Transformers: locate outside with pads and screens where required.
  - Indoor Transformers Over 45 kVA: allow for removal by wheel-mounted equipment.
  - Coordinate transformer heat removal with Mechanical.

- Size:

  - Such that average demand loading is at least 60% of rating.
  - To limit fault current available on the secondary side.

Alberta Infrastructure and Transportation

- Maximum 1,000 kVA per transformer.

- Secondary voltage (listed in order of preference):
  - 347/600 V, three phase, four wire.
  - 120/208 V, three phase, four wire.
  - 120/240 V, single phase, three wire.

- Select low temperature rise transformers using high temperature insulating materials to achieve long life and low losses (e.g., Class 220°C, 150°C temperature rise over a 40°C ambient).

- Provide three-phase transformers with delta-wye connection and accessible voltage taps.

- Rate transformers to accommodate the harmonic currents and voltages present for the loads being supplied. Transformers may be K factor rated or may of the phase shifting type designed to mitigate harmonics.

- Use flexible conduit for final connection to transformer. Use liquid tight flexible conduit in wet areas.

- Make provisions for fan cooling on dry type transformers in excess of 750 kVA. Size transformers for calculated capacity without fan-cooling.

- Acoustical Considerations:
  - Do not locate transformers within instructional spaces or in ceiling spaces above classrooms.
  - For transformers located on or suspended from upper floors, use the following table as a guide for specifying vibration isolators.

Size (kVA)	**Isolator Type**	**Static Deflection**
Under 50	neoprene isolator	10 mm
50 – 250	spring isolator or hanger	19 mm
Over 250	spring isolator or hanger	25 mm

  - Provide flexible conduit to make the connection to the transformer.

.5 Feeders

- Size feeders for a maximum 2% voltage drop from main distribution to branch circuit panelboard under rated full load.

- Generally, use copper conductors for feeders. Panel, MCC and distribution board feeders larger than #6 may be aluminum alloy.

- Provide a 100% rated neutral and bonding conductor with all feeders.

.6 Power Factor

- Correct power factor to 95% where normal loading yields power factor below 90%.

- Provide power factor corrections to individual motors 10 kW and larger or groups of motors totalling 50 kW or larger.

- Locate capacitors close to motor load, usually downstream of starters.

- Where switchable capacitor banks are used, take the following precautions:

  - First in, first out switching.
  - Provide time delay between switch steps.
  - Prevent overcorrecting and cycling.
  - Conduct harmonic analysis and, where necessary, provide harmonic detuning.

.7 Harmonic Distortion and Noise

- Identify non-linear loads including: pulse mode power supplies (typically found in personal computers, photocopiers, fax machines, etc.), UPS, rectifiers, variable frequency drives and electronic ballasts. Determine the effects of these loads on the power distribution system.

- Provide harmonic filtration, either integral with the equipment or separately, to limit total harmonic distortion from each piece of equipment to less than 15%. Limit the harmonic distortions to comply with current edition of IEEE 519.

- Provide transient protection and harmonic filtering in power supply to Data and Communication systems and computer labs.

- Provide transformer isolation between large harmonic generating loads and the balance of the distribution system.

- Use separate neutrals or increase size of neutral of branch circuits where necessary.

.8 Transient Voltage Suppression

- Provide transient voltage surge suppression (TVSS) integral with the distribution equipment. Coordinate suppression with anticipated energy levels and sensitive loads.

- Provide surge suppression in the following manners:

  - Install surge suppression on utility incoming mains.
  - For areas containing a large group of electrically sensitive loads, provide surge protection on panelboards serving the area.
  - Provide individual pieces of sensitive equipment, not otherwise protected, with local surge suppression module (computer power bar or wall plug-in style).
  - Coordinate surge suppression devices within the same power distribution system.

.3 Motor Control

.1 General

- Where there is a three phase service, provide motors larger than 0.37 kW as three phase units and motors 0.37 kW and smaller as single phase, 115 V units.

.2 Motor Starters

- Provide modular grouped assembly motor control centres for three-phase motor starters. These motor control centres include:

  - Standardized central wiring extended to terminal strips in control terminal section.
  - Copper bussing.
  - Combination magnetic starters, minimum size 1.
  - 10-15% spare spaces.
  - Adjustable time delay relays for start-up on motors 5 kW and larger where this feature is not available through building automation system.
  - Individual control transformers in each starter cell.
  - Auxiliary contacts for interlocking controls.

- Provide manual motor protection switches for all non-thermally protected single phase motors.

- Provide control relays in MCC control terminal section for automated control of single phase motors where required.

- Coordinate motor sequential starting with building automation or controls.

.3 Motor Protection and Control

- Do not use fuses for individual motor overcurrent protection.

- Provide three-phase motor starters with three overload protection elements complete with auxiliary contacts for interlocks.

- Provide single phase protection for all three phase motors either by relaying, differential overloads or Building Automation shutdown.

- Provide time delay on speed change for 2 speed starters.
- Provide space on backpan for Building Automation current sensors.

.4 Variable Frequency Drives

- Provide drives complete with harmonic distortion line filters which limit total harmonic current distortion to less than IEEE 519 standard requirements where the drive terminals are the point of common coupling, but in no case more than 15%.

- Use pulse width modulated technology drives.

- Select drives with proven maintenance capabilities.

- Coordinate motor selection with mechanical to ensure inverter duty motors are provided.

- Locate drives within 7 meters of load.

.4 <u>Emergency Power System</u>

.1 General

- Batteries for Standby Applications

  - Make standby battery provisions for:

- Fire alarm system.
- Communication systems.
- Switchgear station power supply, if applicable.
- Engine-generator start-up.
- Systems or equipment which require uninterrupted service.
- Emergency lights and exit signs (where generator is not provided).
- Gas shut off solenoid valves.

- Maintain battery operating ambient temperature above 20°C.

- Provide battery chargers with bulkcharge, overcharge protection and float-charge features.

• Uninterruptible Power System (UPS)

- UPS should be provided for Building Automation System and central computer file servers.

- Minimize battery requirements for UPS by feeding unit from emergency power system where applicable. Size UPS batteries for maximum 20 minute outage except in special cases.

- Provide heavy duty lead-acid, maintenance-free, valve gated sealed batteries.

.2 Emergency Generator

• Generally, emergency generators are not required in school facilities, however, where freeze protection or other essential motor loads are present or where the facility is also used as a disaster recovery centre, an emergency generator may be provided.

• Where emergency generator is provided the following requirements apply:

- Provide independent, self-contained emergency power generation in accordance with CAN/CSA C282 Standard, Emergency Electrical Power Supply for Buildings.

- Comply with CAN/ULC-S524, Standard for the Installation of Fire Alarm Systems (3.2.2), with respect to emergency generation.

- Criteria for generator installation:

  - Dedicated indoor, climate-controlled, fire-rated room. Locate generator room away from noise-sensitive areas and preferably at grade level. Do not locate room below grade or where access for the removal of equipment is impeded.

  - Exclude unrelated electrical and mechanical equipment from generator room.

  - Provide vibration isolation for generator control panel or remote mount from generator set skid.

  - Locate transfer equipment and main emergency distribution in close proximity to (but not within) emergency generator room.

  - Where feasible, provide wired glass view between switchgear and generator room.

  - Make provisions for connection to load bank to facilitate annual full load testing; size only for additional required load.

- Generator Sizing

  - Size emergency generator for minimum 50% demand loading during regular testing.

  - Size generator for peak demand loads plus 20% spare for identified expansion, if applicable.

- Transfer Equipment

  - Provide automatic transfer switch.

  - Provide time delay or in-phase monitoring in transfer scheme to prevent motor damage upon transfer to utility power.

- Provide time delay between start-up of each motor over 5 kW on emergency power after transfer to emergency generator, starting largest motor first.

.5 Lighting

.1 General

- Design to maximize the energy efficiency of lighting systems. Design in accordance with the Model National Energy Code of Canada for Buildings 1997.

- Design to minimize direct and reflected glare and maximize contrast.

- Design lighting system to facilitate and minimize required maintenance through choice of:

  - Long-life lamps (10,000 – 20,000 hour lamp life)
  - Lamps and luminaires to minimize different types.
  - Easy to maintain luminaires.
  - Accessible luminaire components.
  - Optical systems designed for the application, e.g., compact fluorescent luminaires with optical system specifically for the lamp used as opposed to an incandescent luminaire retrofit.
  - Luminaires that have parts such as lenses, ballast's and lamps readily available.

- Provide a design report which includes a schedule describing each typical area, luminaire, lighting source, load (W/m^2) and design lighting levels. Upon project completion add field measured levels to the report.

.2 Recommended Lighting Levels

- Design to the latest IES standards. Specifically refer to IES RP 3 – Guide for Educational Facilities Lighting. Use the following criteria to determine minimum average maintained values within spaces:

  - Visual Task: medium contrast or small size.
  - Occupants Ages: under 40 years of age.
  - Reflectance's: room surfaces and task backgrounds – 30 to 70%
  - Speed at which the task is being performed: varies

- The importance of accuracy when performing the task: varies

.3 Uniformity

- All areas in a space need not be to minimum average maintained values if functions permit. Lighting levels may be non-uniform. For example, circulation areas in an office may be of a lower level than recommended for the work surface.

.4 Luminaires

- Direct/indirect systems are preferred for classroom and office lighting where ceiling height and finishes permit. Reduction of up to 20% from IES recommended illuminance values are permitted where these systems are used. These systems should have at least 50% direct component.
- Only use the task-ambient approach in office spaces where work surface and task orientations are predetermined.
- It is not necessary to design for worst case work surface and task orientations in general office space.
- Provide intermediate supports on diffusers larger than 1,220 × 610 mm.
- Use diffuser with minimum 3.3 mm thickness in metal frame for flat lens larger than 1,220 × 305 mm.
- Only use acrylic, polycarbonate or glass as a material for diffusers.

.5 Lighting Sources

- Limit use of HID sources to indirect lighting systems and high mounting heights. Do not use HID lighting in classrooms.
- Generally, use 1,220 mm (imperial) fluorescent, F32T8 lamps. Do not use “U” lamps.
- Use fluorescent lamps with same colour temperature and colour rendering index throughout all areas.
- Use compact fluorescent luminaires where the 1,220 mm linear fluorescent source is not aesthetically acceptable.

- Use incandescent sources only in the following applications:

  - Where dimming control is required.
  - For accent or display functions.
  - For areas that require the color and effect of incandescent light sources (drama class, stage, etc.).

- Use high pressure sodium for exterior lighting unless economics dictate otherwise.

.6 Ballasts

- Use energy efficient, instant or rapid start, electronic fluorescent ballasts.

- Select electronic ballasts with total current harmonic distortion below 12%.

- Use high power factor ballasts (including compact fluorescent) with a minimum power factor of 0.95 or better.

- Use ballasts (including compact fluorescent) with a minimum ballast factor of 0.85 or better.

- Use potted or encapsulated HID and compact fluorescent lamp ballasts for noise reduction.

.7 Daylighting

- Use daylighting wherever feasible and provide detailed information in design development report.

- Provide an outline of how daylighting is to be integrated into the facility, how automatic control is achieved and how glare is controlled.

.8 Lighting Controls

- Provide each room or area (classroom, library, gymnasium, etc.) with control of the lighting.

- Dimming control:

  - For incandescent, provide adequately-rated dimming units with harmonic and radio frequency interference filters and suitable for quartz halogen lamps.
  - Do not dim HID or fluorescent sources.

- Provide local controls in individual rooms where lighting is not required on a continuous basis. Use motion sensor controlled lighting only where economics are favourable.

- In rooms where audio/visual presentations are likely, provide a second level of lighting through switching a small number of luminaries separately from the main lighting. Do not use center lamp switching of three lamps luminaries.

- Limit use of low voltage switching to 347 volt distribution and in large areas that require central control or multiple switching (hallways, corridors and gymnasium). Where it is justified, however, a low voltage switching system may be considered for energy management.

- Do not use breaker switching.

.9 Exterior Lighting

- Minimize exterior lighting. Avoid generalized exterior security lighting. Restrict exterior lighting to pedestrian and vehicle access routes.

- Select luminaire types and placement to minimize vandalism and to prevent offensive light spill onto neighboring properties. Use full cutoff luminaries for all parking, roadway and area lighting.

- Employ ultraviolet stable polycarbonate or tempered glass lenses.

- Use of motion sensor control quartz floods is recommend for 24-hour security lighting.

.10 Emergency Lighting

- Use emergency lighting sources that restrike immediately upon energization.

- Provide self-contained emergency lighting battery packs in major electrical rooms and generator room. Battery packs to have a minimum of one hour capacity for the connected load.

.11 Exit Luminaries

- Use high brightness LED type exit lights.

.6 Wiring Materials and Methods

.1 General

- Provide separate circuits for coffee makers, refrigerators and microwave ovens.
- Provide a comprehensive colour coding and identification system for all electrical systems.

.2 Conductors

- Use copper conductors with RW90 X-link or THNN insulation.
- Avoid the use of non-metallic sheathed cables, except for buildings entirely of combustible construction.
- Use AC-90 cable only in short lengths for final connections to luminaries and similar equipment and for wiring between outlets in stud walls.
- Size branch circuit conductors to avoid excessive voltage drops. Indicate conductor sizing in construction documents.

.3 Conduit and Raceways

- Provide underground service entrance in duct bank with steel reinforced concrete encased PVC or FRE duct. Provide transition at foundation wall, manholes etc., with rigid steel conduit. Provide a minimum of one spare conduit in each duct bank.
- Provide wiring in conduit throughout (except where NMD90 and AC90 cables are used).
- Provide sufficient length of flexible drop to luminaries to enable unit relocation 2 m in any direction. Drops are to occur from junction box on structure to each luminaire.
- Record exact routing of conduit runs in floor slabs. Do not loop through to down stream outlets.
- Where conduit is used in ceiling plenums, use FT4 low flame spread rated PVC conduit.
- Install multiple conduit runs on racks. Provide 25% spare capacity on rack for future additions.

- Provide ventilated cable tray for low tension systems, Class C1, ladder type. Tray to consist of open top cable tray with minimum dimensions of 450 mm wide × 100 mm deep, galvanized steel. Support cable tray from the building structure at 3 m on centre. Where cable tray passes through fire rated walls, provide total enclosed tray for a distance of 200 mm on each side of the wall.

- For low tension systems, only provide conduit for final drops in finished walls and where ceiling space is not accessible. Otherwise use open wiring methods.

.4 Wiring Devices and Equipment

- Use specification grade receptacles in all locations.

- Identify all receptacles as to panel and circuit number on plastic engraved lamicoid tag, permanently affixed to wall directly above device cover plate; tag to be same width as cover plate.

.5 Provisions for Computer Based Equipment

- Determine the extent and severity of electrical service disturbances including voltage sags, surges, short term and long term transients and outages. Consult with the Utility to determine the likely incidence of these disturbances.

- Identify electronic equipment and systems likely to be affected by these disturbances and the extent of protection necessary for normal operation.

- Provide electrical protection and line power conditioning for affected equipment as follows:

  - Surge protectors – electronic or varistor surge arrestors for equipment affected by transients.
  - Isolation transformers - electrostatically shielded transformers for equipment affected by transients and noise.
  - Regulated power supplies – for equipment and systems affected by transients, noise, voltage sags and surges.
  - Electronic filters – for equipment affected by harmonics and noise.
  - Uninterruptible power supplies – for equipment requiring continuity of service.

- Computer Grade Circuits

  - Provide computer grade circuits consisting of breakers, raceways, wire, outlets and receptacles designed to provide power to electronic equipment.
  - Supply only electronic equipment with these circuits. Do not use these circuits to supply convenience receptacles or mechanical equipment.
  - Generally supply only two outlets or piece of equipment per circuit. Review the options for circuiting with user.
  - Do not use common neutrals.
  - With sufficient circuits at one location to justify its installation, provide a separate panelboard fed by an electrostatically shielded transformer.

.6 Block Heater Outlets

- For more than 10 and up to 30 parking stalls:

  - Provide thermostatic controlled contactors designed to shut off all power to outlets when outside temperature is above -10°C.
  - Provide timer to cycle energized outlets on and off at a maximum 20 minute period.

- More than 30 parking stalls:

  - Provide thermostatic controlled contactors designed to shut off all power to outlets when outside temperature is above -10°C.
  - Split the load into two groups. Alternately cycle each group on and off with a maximum 20 minute period.

- Provide control of block heater outlets from mechanical Energy Management Control System (EMCS) where provided.

.7 Provisions for Mechanical

- Provide heat tracing for piping or connect immersion heater in accordance with Section 3, MECHANICAL.

- Provide UPS for head end of Building Automation systems in consultation with School Board.

.7 Fire Alarm System

.1 General

- Design and install system to latest CAN/ULC-S524 Standard, Installation of Fire Alarm System.
- Verify system to latest CAN/ULC-S537 Standard, Verification of Fire Alarm System.
- Review design of fire alarm system with local authority.
- Select system vendors with local support. Do not use proprietary equipment.

.2 System

- Use programmable intelligent fully addressable technology except in rural locations where response by factory service personnel is difficult and expensive, or where system size does not warrant this technology, then the use of conventional hard wired system is encouraged.
- Provide fire alarm as a stand alone system, independent of building control or security systems.
- Coordinate fire alarm zoning with sprinkler system and illustrate zoning graphically.
- Annunciate emergency generator – run and trouble modes where applicable.
- Provide 10% spare fire alarm and detection zones unless the expansion requirements are identified.
- Provide details of the coordinated smoke control plan in design report.
- Provide fire rated wiring installation for system communications trunks where they are used. Wiring to individual zone or device will not require fire rating.
- Provide magnetic door hold open devices on circulation doors where smoke or fire separations are required to alleviate need for door "stops" by facility staff.

- Provide wiring diagram on inside of each fire alarm panel door. Clearly identify wiring at all panels and junction boxes identifying zones.

- Co-ordinate duct detectors with mechanical to ensure air velocities are compatible with detectors.

.8 Security Systems

.1 General

- Provide electronic security systems only as required to enhance physical and dynamic security. Primary security is by physical security provisions in the building design and the dynamic security brought about through staff procedures and circulation.

- Review security risks with administration and determine needs for each individual project.

- Provide emergency power supply to security systems and battery backup where warranted.

.2 Security System Application

- Provide security television coverage only as necessary for:
  - Access control.
  - Monitoring of secure areas.

- Provide security television system with point to point service as opposed to video switching.

- Do not use security television pan/tilt/zoom cameras, video motion detectors, nor time lapse recording equipment.

- Provide perimeter security to detect unauthorized exit or entry. Perimeter door monitor system with internal motion sensors is adequate in most applications.

.9 Data and Communication Systems

.1 General

- Provide wiring terminal closets and equipment rooms to accommodate data and communications systems in accordance with CAN/CSA T529, EIA/TIA 568 Standard.

.2 Data Cabling

- Provide data cabling required to meet the users needs as part of the building construction contract.
- Provide outlets and wiring or empty raceways to future workstations.
- Provide data raceways physically separated from power and other low voltage systems.
- Raceways are only required for group runs or runs in exposed locations or plaster ceiling and block walls.
- Provide wiring, patch panels and jacks for a complete Data Cable System to EIA/TIA Category 5e standards.
- Ensure final installation is tested for compliance. "Manufacturing certification is not necessary."

.3 Telephone Cabling

- Provide telephone system cables and outlets as part of the building construction contract.

.4 Communication Systems

- Provide public address and telephone systems to meet the needs of the facility.
- Telephone System
    - The telephone system may be purchased through the construction contract or separately by the School Board.
    - A small digital PABX system may be used to provide both telephone and intercom services.
- Intercom System
    - Provide building intercom requirements through telephone system with the exception of:
        - Point-to-point staff entry door intercom
        - Separately identified functions
    - Provide speakers and handsets in all applicable locations.

- Provide zoning to suit facility function, i.e., separate zones in wings of school.

- Provide gymnasium sound reinforcement system:

  - Provide a fixed sound system that is suitable for highly intelligible speech reinforcement and music.
  - Select loudspeaker directivity and mounting locations to provide uniform sound coverage of the floor area and minimize any spill over to wall surfaces.
  - For systems that will be used for frequent drama and musical productions, provide 25 mm conduit from the audio equipment location on stage to a location near the center of the back wall of the gymnasium. Provide recessed junction boxes at both ends. This is to provide a future tie-in for a portable mixer.

- Provide hearing assist systems in areas as required:

  - Specify high sub-carrier frequency system (2.3 – 2.8 MHz) to avoid interference from electronic light ballasts.

.5 Cable Television System

- Design cable television distribution system for signal strength 6 dB mV to 14 dB mV at each outlet.

- Connect utility cable television service to cable television distribution system. If cable television is not available at present ensure that it can be connected when service is available.

- Provide outlets in each classroom and in areas such as lounges, auditoriums, etc.

- Do not specify Media Retrieval Systems.

.10 <u>Miscellaneous</u>

.1 Lightning Protection

- Provide lightning arrestors on all services supplied from an overhead line.

- As a guideline, provide lightning protection as determined by the Risk Assessment Guide CAN/CSA-B72-M87 but generally for the following:

- Structures in urban areas which are taller than adjacent structures within a 500 m radius.
- Structures in rural areas which are taller than adjacent structures or trees within a 100 m radius.

• Do not provide protection for adequately grounded metal buildings.

.2 Envelope Penetrations

• Ensure adequate treatment for all envelope penetrations such as generator exhaust piping, lightning down conductors and points and service masts. Refer to Building Envelope Section for specific requirements.

.3 System Demonstration and Commissioning

• General

- All electrical systems to be included in the commissioning process.

- A commissioning program will be carried out involving the Consultants, Contractors, Testing Agencies and School Boards.

- Perform tests in accordance with:

    - Applicable CSA, IEEE, IPCEA, EEMAC, NEMA and ASTM Standards.
    - Requirements of authorities having jurisdiction.
    - Manufacturer's published instructions.
    - Contract documents.

- Prior to testing, ensure all electrical equipment is cleaned and free of dust.

- After testing, protect equipment subject to dust from construction activities.

- School Board or School Board Testing Agent may witness all or any portion of testing and starting procedures performed by the Contractor.

- The Contractor shall be present for all tests specified.

- Basic Electrical Startup and Testing

  - Test and check all portions of the electrical systems for satisfactory operation.

  - Before energizing any portion of the electrical systems:

    - Perform megger tests on all feeders.
    - Check load balance with all loads energized. Load unbalance to be no greater than 15%.
    - Take ampere readings for all mechanical equipment with motors running under full load condition.
    - Test and calibrate all protective devices on site prior to energizing to ensure proper operation as determined by final coordination studies.
    - Complete fire alarm verification as per current edition of CAN-5537, Standard for Verification of Fire Alarm System.
    - Test data network as per industry standard.
    - Test signal strength at each cable television outlet and provide verification that signal levels meet specified requirements.